WHP Cruise Summary Information

WOCE section designation	P17N
Expedition designation (EXPOCODE)	325021_1
Chief Scientist(s) and their affiliation	David Musgrave, UA
Dates	1993.05.15 - 1993.06.26
Ship	THOMAS THOMPSON
Ports of call	San Francisco, California-Sitka, Alaska
Number of stations	207
Geographic boundaries of the stations	57°19.91''N 159°06.06''W 123°49.54''W 34°34.90''N
Floats and drifters deployed	none
Moorings deployed or recovered	none
Contributing Authors	M. Aoyama R.M. Key P.D. Quay

WHP Cruise and Data Information

Instructions: Click on items below to locate primary reference(s) or use navigation tools above.

Cruise Summary Information	**Hydrographic Measurements**
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure)	CTD - conductivity/salinity
Description of stations	CTD - dissolved oxygen
	Salinity
Floats and drifters deployed	Oxygen
Moorings deployed or recovered	Nutrients
Principal Investigators for all measurements	
Cruise Participants	
Problems and goals not achieved	
Other incidents of note	Other parameters
Underway Data Information	**Acknowledgments**
Navigation	**References**
Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	**DQE Reports**
Thermosalinograph and related measurements	
XBT and/or XCTD	CTD
Meteorological observations	S/O2/nutrients
Atmospheric chemistry data	
	Data Status Notes

A. Cruise Narrative

A.1 Highlights

A.1.a WOCE designation P17N

A.1.b EXPOCODE 325021/1

A.1.c Chief Scientist
David L. Musgrave
University of Alaska
Fairbanks, AK
phone: 907-474-7837
fax: 907-474-7204
e-mail: musgave@ims.alaska.edu

A.1.d Ship

A.1.e Ports of call San Francisco, California-Sitka, Alaska (USA)

A.1.f Cruise dates 15-May-1993 to 26-Jun-1993

A.2 Cruise Summary Information

A.2.a Geographic boundaries

	57N	
158W		123W
	38N	

A.2.b Stations occupied

Stations were numbered consecutively from the beginning of the cruise. *202 CTD/36 bottle rosette stations, 47 with LADCP

1. 127 WOCE stations (1-99,121-148), 33 with LADCP
2. 21 coastal stations into Alaska Peninsula (100-120), 0 with LADCP
3. 39 Sitka Sound stations (149-187), 0 with LADCP
4. 16 Sitka Eddy stations (188-203), 14 with LADCP

* 10 Large volume sampling (Gerard barrel) stations

A.2.c Floats and drifters deployed

A.2.d Moorings deployed or recovered

A.3 List of Principal Investigators

Table1: List of Principal Investigators

Name	Parameter	Institution
Rana Fine	CFC	RSMAS
Teresa Chereskin	ADCP, LADCP	SIO
Wilf Gardner	Transmissometer	TAMU
Catherine Goyet	Carbon Dioxide	WHOI
Charles Keeling	Carbon Dioxide	SIO
Robert Key	Large Volume Carbon-14 Radium-228	Princeton
John Lupton	Helium-3	NOAA/PMEL
Dave Musgrave	CTD-hydrography	IMS-UAF
Tom Royer	CTD-hydrography	IMS-UAF
Paul Quay	AMS Carbon-14	UW
Jim Swift	CTD-hydrography and nutrients support	SIO-ODF
Zafir Top	Helium-3, Tritium	RSMAS
Rick Thomson	Surface Drifters	IOS/BC

Disposition of data: please contact the individual investigators listed above. We are following the US WHP data policy, by which all preliminary results are immediately available to all US WOCE investigators funded for Pacific basin projects, with proprietary rights for two years for usage and publication of the data given to the individual investigator responsible for each particular measurement. Any use of publication of these data without permission from the principal investigator responsible for that measurement is in violation of this agreement. Collaborative work is encouraged.

A.4 Scientific Programme and Methods

The R/V Thompson departed San Francisco for cruise 21 (leg 01) on 15-May-1993. This was the first WOCE hydrographic cruise on the R/V Thompson. P17N was supported by the National Science Foundation's Ocean Science Division. The Ocean Data Facility of Scripps Institution of Oceanography (ODF/SIO) provided the basic technical support for this cruise. Because of their sea-going experience with the WOCE Hydrographic Program (WHP) and their prior support of JGOFS activities on the R/V Thompson, we had very few problems with equipment. The worst problem seemed to be occasional malfunctioning of the General Oceanics pylon. We had extremely good weather (for the Northeast Pacific) and were delayed only two times: due to weather for about 24 hours at station 72 and for about 8 hours at a non-WOCE station (194). We had three weather days planned and gained additional days due to a cruising speed of slightly greater than 10 knots. The additional days were spent on hydrographic work on the Alaska Peninsula shelf, in Sitka Sound and offshore of Sitka.

All WOCE stations were to the bottom and included a rosette/CTD cast. Basic station spacing in the open ocean was 30 nm, with higher resolution in regions of steep topography (off Pt. Arena, California, over the Mendicino "Ridge," over the Aleutian

Trench, and at the shelf break into Sitka). The Alaska Peninsula and Sitka Sound stations were to the bottom (generally less than 200 m) and the Sitka Eddy stations were to the bottom or 1000m or 2000 m.

Sampling was done with a 36-place General Oceanics pylon on a rosette frame with 10-liter bottles and a CTD (SIO/ODF CTD \#1), transmissometer, altimeter, and pinger. The CTD data stream consisted of elapsed time, pressure, two temperature channels, conductivity, oxygen, altimeter and transmissometer signals. All WOCE profiles were full water column depth. Water samples were collected for analyses of salt, oxygen, silica, phosphate, nitrate, nitrite on all stations and of CFC-11, CFC-12, helium-3, helium-4, tritium, AMS C14, total CO_2 and total alkalinity on selected stations.

A Lowered Acoustic Doppler Current Profiler was mounted to the rosette frame which was specially made so that no bottles needed to be removed. The LADCP was mounted only for stations near steep bathymetry. It's pressure case was rated to 5500 dbar so at station 87 at the crossing of the deepest part of the Aleutian Trench (6000 m), the LADCP was dismounted and then remounted for a second cast. The time to mount or dismount the LADCP was about one-half hour since the rosette needed to be partially dismantled.

Large volume sampling was made with 270 liter Gerard barrels for analyses of C14 Ra(228), salinity, oxygen, and nutrients on 10 stations. We had very good weather for all the Large Volume Stations and had no problems with pre-trips (wire speeds of 30 meters/minute for down-casts). The time for the LVS's was greater than that allotted for in the cruise plan. However, the time gained by cruise speeds greater than 10 knots more than made up for the lost time on the LVS's.

A.5 Major Problems and Goals not Achieved

No major problems were encountered on the cruise. The wind speed and direction of the IMET system failed early in the cruise. The shipboard underway system did not log data until station 10 due to a software error.

The GO pylon had major problems in firing bottles, however all misfirings were detectable and the console operator was able to compensate for the misfires.

A.6 Other Incidents of Note

A.7 List of Cruise Participants

Table 2: List of Cruise Participants

	Name	Institution	Responsibility
1	Dave Musgrave	UAF	Chief Scientist
2	Tom Royer	UAF	Co-Chief Scientist
3	Robert T. Williams	STS/ODF	Data/Marine Tech, WLdr, Oxygen
4	Carl Mattson	STS/ODF	Electronics Specialist
5	Dave Muus	STS/ODF	Data/Marine Tech, WLdr
6	Dave Nelson	STS/ODF/URI	Marine Tech
7	Stacey Morgan	STS/ODF	Oxygen/Nutrients
8	Dennis Guffy	STS/ODF/TAMU	Nutrients
9	Laura Goepfert	STS/ODF	Marine Tech/Salt
10	Marie-Claude Beaupre	STS/ODF	Nutrients/Oxygen
11	Craig Hallman	STS/ODF	Marine Tech/Salt
12	Teri Chereskin	SIO	ADCP,LADCP
13	Rich Rotter	Princeton	Large Volume extractions
14	Georges Paradis	PMEL	Helium sampling
15	Chris Heuer	RSMAS	Helium/tritium sampling
16	Emma Bradshaw	RSMAS	CFC
17	Kevin Maillet	RSMAS	CFC
18	Maren Tracy	WHOI	CO2
19	Bob Adams	WHOI	CO2
20	Aaron Smith	WHOI	CO2
21	Rolf Sonnerup	UW	AMS 14C
22	Steve Sweet	UAF	Watch Stander
23	Heather Hunt	UAF	Watch Stander

Table 3: Institutions

NOAA/PMEL	NOAA Pacific Marine Environmental Laboratory 7600 Sand Point Way NE Seattle, WA 98115-0700
SIO	Scripps Institution of Oceanography University of California of San Diego 9500 Gilman Drive La Jolla, CA 92093
TAMU	Texas A&M University Department of Oceanography College Station, TX 77843
WHOI	Woods Hole Oceanographic Institute Woods Hole, Ma 02543

Princeton	Princeton University Princeton, NJ 08540
RSMAS	Rosential School of Marine and Atmospheric Science Miami, FL
UAF	University of Alaska Fairbanks, AK
UW	University of Washington School of Oceanography Seattle, WA 98195

B. Underway Measurements

B.1 Navigation and bathymetry

Navigation data and underway bathymetry was acquired from the ship's Bathy 2000 system via RS-232. It was logged automatically at one-minute intervals by one of the Sun Sparcstations to provide a time-series of underway position, course, speed and bathymetry data. These data were used for all station positions, PDR depths, and for bathymetry on vertical sections.

B.2 Acoustic Doppler Current Profiler (ADCP)

An ADCP was run while underway.

B.3 Thermosalinograph and underway dissolved oxygen, etc

pCO was collected while underway.

B.4 XBT and XCTD

B.5 Meteorological observations

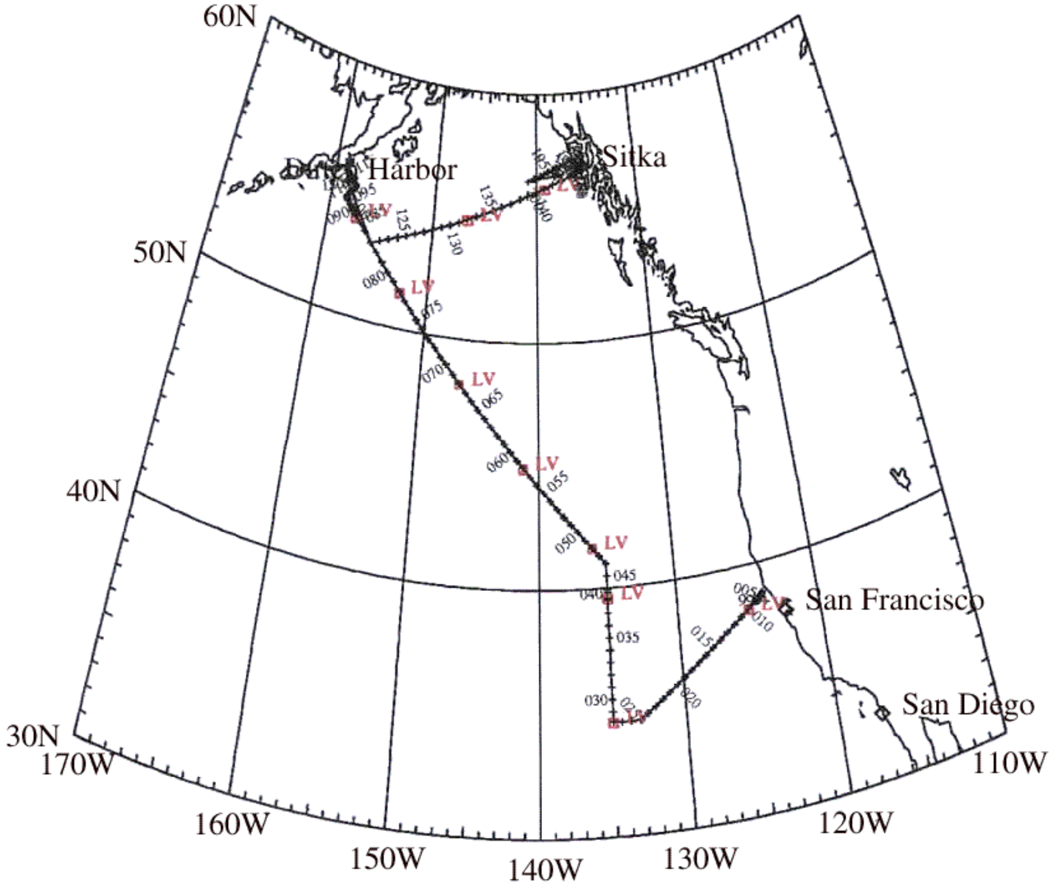
Thompson's IMET system collected (surface water temperature and conductivity, meteorological parameters, GPS navigation, ship's speed and heading) and bathymetry from the shipboard PDR. The IMET's wind speed and direction sensor malfunctioned early in the cruise.

B.6 Atmospheric chemistry

C. Hydrographic Measurements (ODF report)

World Ocean Circulation Experiment
Pacific Ocean P17N
R/V Thomas G. Thompson
Voyage TT021
15 May - 26 June 1993
San Francisco, California - Sitka, Alaska
Expocode: 325021/1

Chief Scientist: Dr. David L. Musgrave
University of Alaska, Fairbanks



WOCE-93 P17N Cruise Track

Oceanographic Data Facility (ODF)
Final Cruise Report
December 19, 1995

Data Submitted by:
Oceanographic Data Facility
Scripps Institution of Oceanography
La Jolla, CA 92093-0214

1. DESCRIPTION OF MEASUREMENT TECHNIQUES AND CALIBRATIONS

Basic Hydrography Program

The basic hydrography program consisted of salinity, dissolved oxygen and nutrient (nitrite, nitrate, phosphate and silicate) measurements made from bottles taken on CTD/rosette casts plus pressure, temperature, salinity and dissolved oxygen from CTD profiles. 202 CTD/Rosette casts were made, usually to within 10 meters of the bottom. Of these 202 casts, there were a total of 128 WOCE casts. 10 Large Volume stations were occupied with two casts per station. On the WOCE stations, 4343 bottles were tripped resulting in 4319 usable bottles. No major problems were encountered during any phase of the operation. The resulting data set met and in many cases exceeded WHP specifications. The distribution of samples is illustrated in figures 1.0.0, 1.0.1 and 1.0.2.

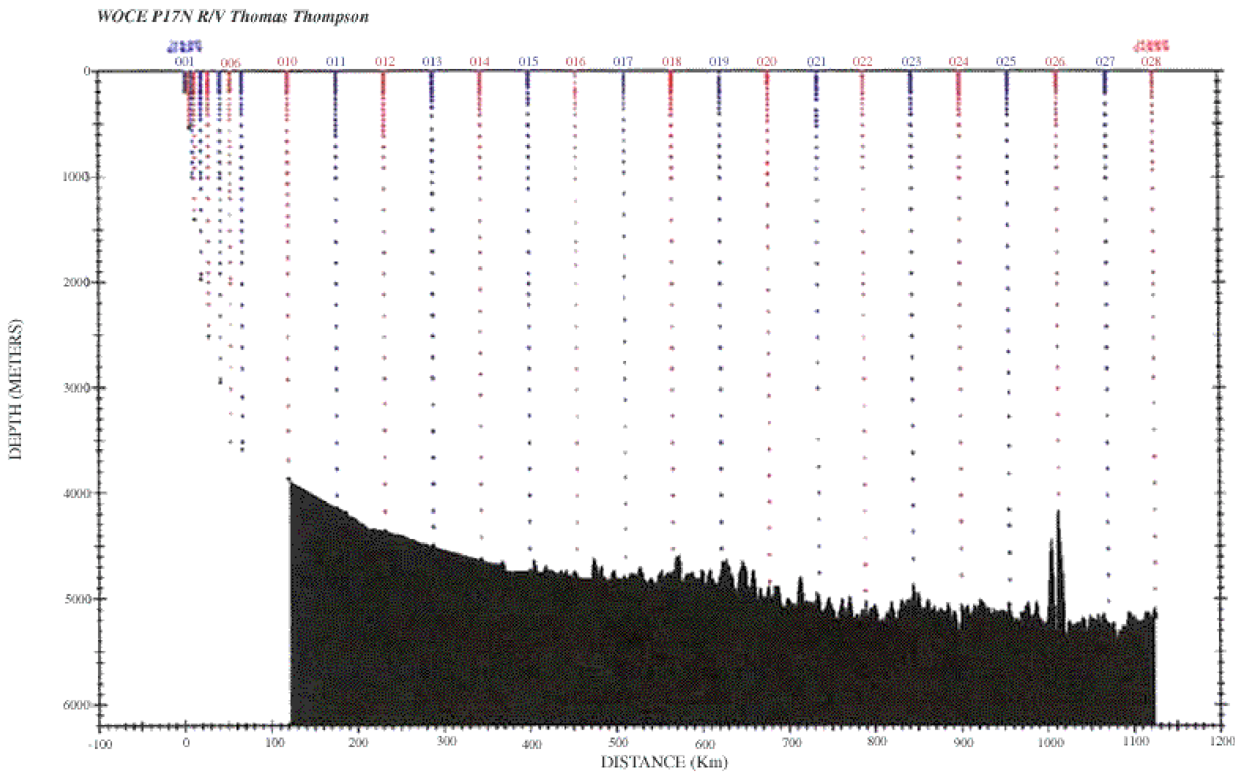


Figure 1.0.0 Sample distribution, stations 001-028

1.1. Water Sampling Package

Hydrographic (rosette) casts were performed with a new design of the rosette system consisting of a 36-bottle ODF-designed rosette frame, a 36-place pylon (General Oceanics 1016) and 36 10-liter Bullister-style PVC bottles. The frame worked well and held the Lowered Acoustic Doppler Current Profiler (LADCP) without sacrificing any of the 36 samplers. The G.O. pylon had operating problems which could usually be overcome by the operator through the diagnostics routine. The Bullister-style samplers worked well, but had fragile end-cap edges and tight valves. Recommendations for modifications were made and have since been implemented. Underwater electronic components consisted of an ODF-modified NBIS Mark III CTD (ODF #1) and associated sensors, SeaTech transmissometer provided by Texas A&M University (TAMU), RDI LADCP, Benthos altimeter and Benthos pinger. The CTD was mounted horizontally along the bottom of the rosette frame, with the transmissometer, dissolved oxygen and secondary PRT sensors deployed alongside. The LADCP was mounted vertically in the frame inside the bottle rings. The Benthos altimeter provided distance-above-bottom in the CTD data stream. The Benthos pinger was monitored during a cast with a precision depth recorder (PDR) in the ship's laboratory. The rosette system was suspended from a three-conductor electro-mechanical (EM) cable. Power to the CTD and pylon was provided through the cable from the ship. Separate conductors were used for the CTD and pylon signals.

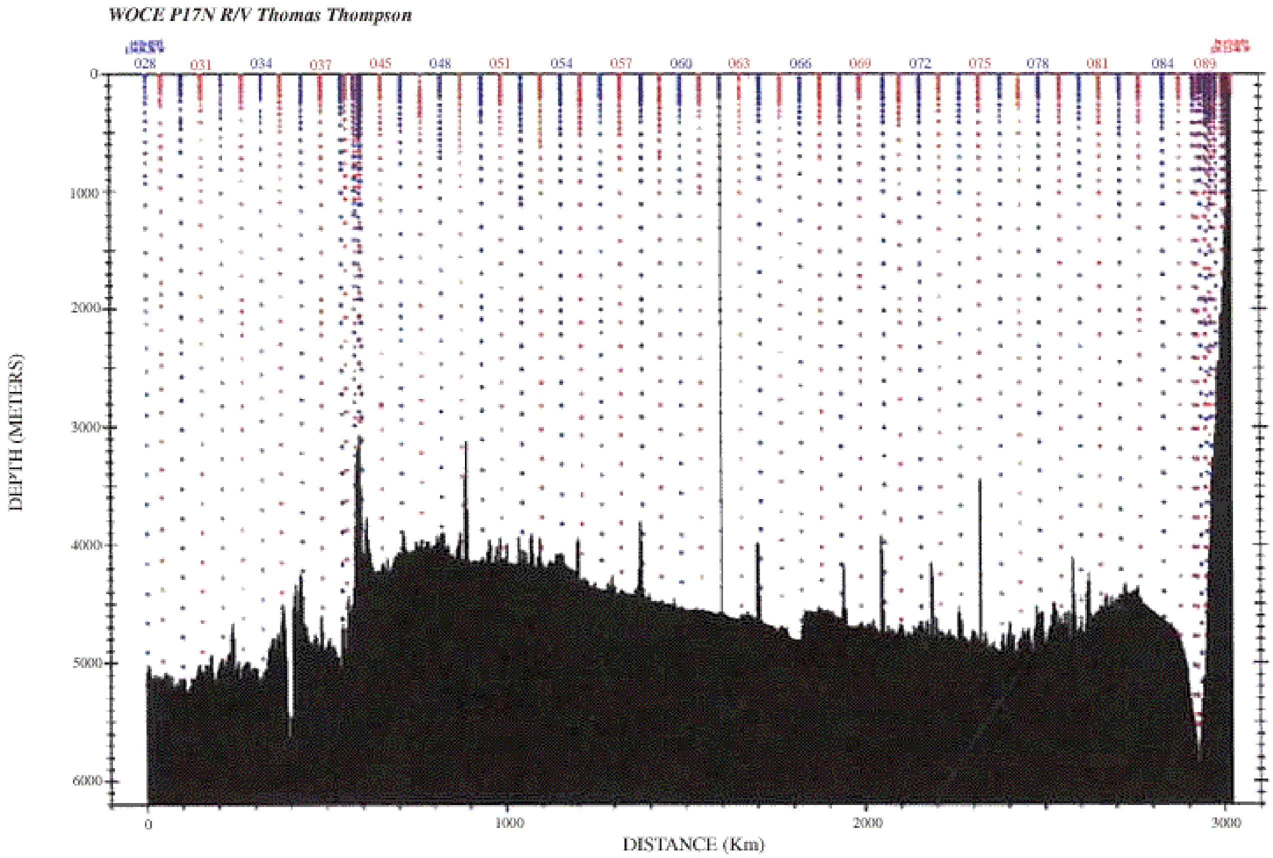


Figure 1.0.1 Sample distribution stations 028-099

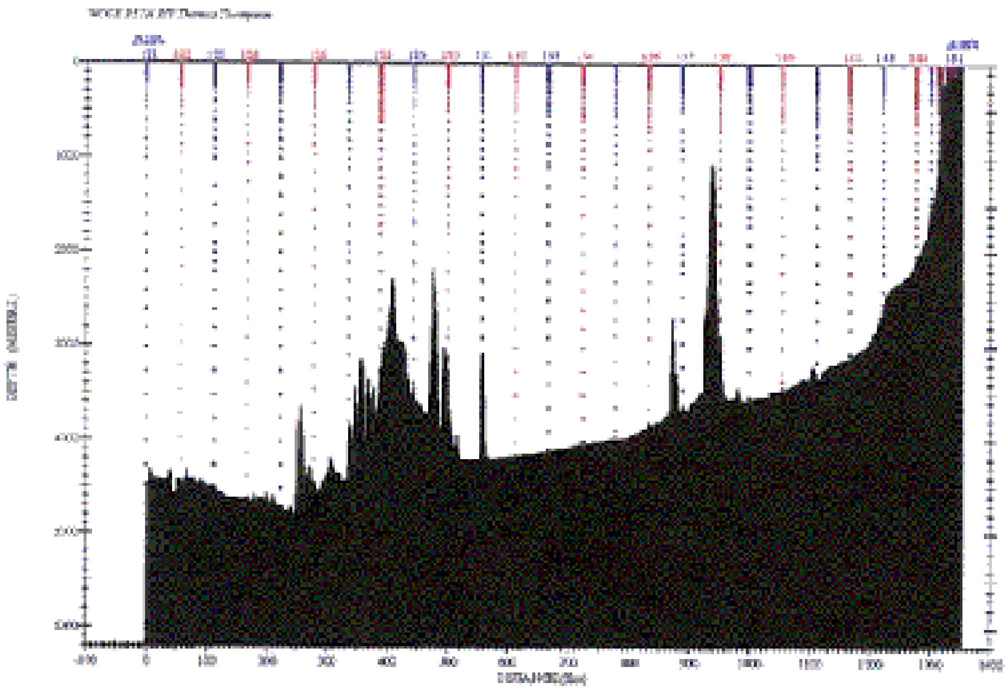


Figure 1.0.2 Sample distribution, stations 121-155

Each rosette cast was performed to within 10 meters of the bottom, unless the bottom returns from both the pinger and altimeter were extremely poor. Bottles on the rosette were each identified with a unique serial number. Usually these numbers corresponded to the reverse of the pylon tripping sequence, 1-36, with the first bottle tripped being bottle #36 (deepest bottle). Bottle replacements were necessary, and the replacement bottles were numbered 37 and 38. Averages of CTD data corresponding to the time of bottle closure were associated with the bottle data during a cast. Pressure, depth, temperature, salinity, density and nominally-corrected oxygen were immediately available to facilitate examination and quality control of the bottle data as the sampling and laboratory analyses progressed.

The deck watch prepared the rosette approximately 45 minutes prior to a cast. All valves, vents and lanyards were checked for proper orientation. The bottles were cocked and all hardware and connections rechecked. Upon arrival on station, time, position and bottom depth were logged and the deployment begun. The rosette was moved into position under a projecting boom from the rosette room using an air-powered cart on tracks. Two stabilizing tag lines were threaded through rings on the frame. CTD sensor covers were removed and the pinger turned on. Once the CTD acquisition and control system in the ship's laboratory had been initiated by the console operator and the CTD and pylon had passed their diagnostics, the winch operator raised the package and extended the boom over the side of the ship. The package was then quickly lowered into the water, the tag lines removed and the console operator notified by radio that the rosette was at the surface.

Recovering the package at the end of deployment was essentially the reverse of the launching. Two tag lines connected to air tuggers and terminating in large snap hooks were manipulated on long poles by the deck watch to snag recovery rings on the rosette frame. The package was then lifted out of the water under tension from the tag lines, the boom retracted, and the rosette lowered onto the cart. Sensor covers were replaced, the pinger turned off and the cart with the rosette moved into the rosette room for sampling. A detailed examination of the bottles and rosette would occur before samples were taken, and any extraordinary situations or circumstances were noted on the sample log for the cast.

Rosette maintenance was performed on a regular basis. O-rings were changed as necessary and bottle maintenance performed each day to insure proper closure and sealing. Valves were inspected for leaks and repaired or replaced.

Large Volume Sampling (LVS) [Key91] was also performed on this expedition. These casts were carried out with ~270-liter stainless steel Gerard barrels on which were mounted 5-liter bottles with deep-sea reversing thermometers (DSRTs). Samples for salinity, silicate and ^{14}C were obtained from the Gerard barrels; samples for salinity and silicate were drawn from piggyback Niskin-style bottles. The salinity and silicate samples from each piggyback bottle were used for comparison with the Gerard barrel salinity and silicate to verify the integrity of the Gerard sample.

1.2. Underwater Electronics Packages

CTD data were collected with a modified NBIS Mark III CTD (ODF CTD #1). This instrument provided pressure, temperature, conductivity and dissolved O_2 channels, and additionally measured a second temperature (FSI temperature sensor) as a calibration check. Other data channels included elapsed-time, an altimeter, several power supply voltages and a transmissometer. The instrument supplied a standard 15-byte NBIS-format data stream at a data rate of 25 fps. Modifications to the instrument included a revised dissolved O_2 sensor mounting; ODF-designed sensor interfaces for the FSI PRT and the SeaTech transmissometer; implementation of 8-bit and 16-bit multiplexer channels; an elapsed-time channel; instrument id in the polarity byte and power supply voltages channels.

The O_2 sensor was deployed in an ODF-designed pressure-compensated holder assembly mounted separately on the rosette frame and connected to the CTD by an underwater cable. The transmissometer interface was designed and built by ODF using an off-the-shelf 12-bit A/D converter.

Although the secondary temperature sensor was located within 1 meter of the CTD conductivity sensor, it was not sufficiently close to calculate coherent salinities. It was used as a secondary temperature calibration reference rather than as a redundant sensor, with the intent of eliminating the use of mercury or electronic DSRTs as calibration checks.

Standard CTD maintenance procedures included soaking the conductivity sensor in deionized water and placing a cap on the O_2 sensor between casts to maintain sensor stability, and protecting the CTD from exposure to direct sunlight or wind to maintain an equilibrated internal temperature.

The General Oceanics 1016 36-place pylon was used in conjunction with the General Oceanics pylon deck unit. There were numerous tripping problems caused by the G.O. pylon/deck unit combination. Usually these could be resolved by the console operator via the pylon diagnostics routine. The pylon emitted a confirmation message containing its current notion of bottle trip position, which was an aid in sorting out mis-trips. A further consequence of Using the G.O. pylon and deck unit also contributed to the magnitude of the variance of salinity differences. The pylon would take a variable amount of time to trip a bottle after the trip had been initiated. The time varied from 5 seconds to over 30 seconds. The acquisition software began averaging data corresponding to the rosette trip as soon as the trip was initiated, ending when the trip confirmed. Consequently, CTD rosette trip data used for the differences contained variable-length averages.

1.3. Navigation and Bathymetry Data Acquisition

Navigation data and underway bathymetry was acquired from the ship's Bathy 2000 system via RS-232. It was logged automatically at one-minute intervals by one of the Sun Sparcstations to provide a time-series of underway position, course, speed and bathymetry data. These data were used for all station positions, PDR depths, and for bathymetry on vertical sections [Cart80].

1.4. CTD Data Acquisition, Processing and Control System

The CTD data acquisition, processing and control system consisted of a Sun SPARCstation 2 computer workstation, ODF-built CTD deck unit, General Oceanics pylon deck unit, CTD and pylon power supplies, and a VCR recorder for real-time analog backup recording of the sea-cable signal. The Sun system consisted of a color display with trackball and keyboard (the CTD console), 18 RS-232 ports, 2.5 GB disk and 8 mm cartridge tape. One other Sun SPARCstation 2 system was networked to the data acquisition system, as well as to the rest of the networked computers aboard the Thompson. These systems were available for real-time CTD data display as well as for providing hydrographic data management and backup. Each Sun SPARCstation was equipped with a printer and an 8-color drum plotter.

The CTD FSK signal was demodulated and converted to a 9600 baud RS-232C binary data stream by the CTD deck unit. This data stream was fed to the Sun SPARCstation. The pylon deck unit was connected to the data acquisition system through a serial port, allowing the data acquisition system to initiate and confirm bottle trips. A bitmapped color display provided interactive graphical display and control of the CTD rosette sampling system, including real-time raw and processed data, navigation, winch and rosette trip displays.

The CTD data acquisition, processing and control system was prepared by the console watch a few minutes before each deployment. A console operations log was maintained for each deployment, containing a record of every attempt to trip a bottle as well as any pertinent comments. Most CTD console control functions, including starting the data acquisition, were performed by pointing and clicking a trackball cursor on the display at icons representing functions to perform. The system then presented the operator with short dialog prompts with automatically-generated choices that could either be accepted as default or overridden. The operator was instructed to turn on the CTD and pylon power supplies, then to examine a real-time CTD data display on the screen for stable voltages from the underwater unit. Once this was accomplished, the data acquisition and processing was begun and a time and position automatically associated with the beginning of the cast. A backup analog recording of the CTD signal was made on a VCR tape, which was started at the same time as the data acquisition. A rosette trip display and pylon control window then popped up, giving visual confirmation that the pylon was initializing properly. Various plots and displays were initiated. When all was ready, the console operator informed the deck watch by radio.

Once the deck watch had deployed the rosette and informed the console operator that the rosette was at the surface (also confirmed by the computer displays), the console operator provided the winch operator with a target depth (wire-out) and lowering rate (normally 60 meters/minute for this package). The package would then begin its descent.

The console operator examined the processed CTD data during descent via interactive plot windows on the display, which could also be run at other workstations on the network. Additionally, the operator decided where to trip bottles on the up-cast, noting this on the console log. The PDR was monitored to insure the bottom depth was known at all times.

The watch leader assisted the console operator when the package was ~400 meters above the bottom, and verify the range to the bottom using the distance between the bottom reflection and pinger signal displayed on the PDR. Between 300 to 60 meters above the bottom, depending on bottom conditions, the altimeter typically began signaling a bottom return on the console. The winch and altimeter displays allowed the watch leader to refine the target depth relayed to the winch operator and safely approach to within 10 meters of the bottom.

Bottles were tripped by pointing the console trackball cursor at a graphic firing control and clicking a button. The data acquisition system responded with the CTD rosette trip data and a pylon confirmation message in a window. All tripping attempts were noted on the console log. The console operator then directed the winch operator to the next bottle stop. The console operator was also responsible for generating the sample log for the cast.

After the last bottle was tripped, the console operator directed the deck watch to bring the rosette on deck. Once on deck, the console operator terminated the data acquisition and turned off the CTD, pylon and VCR recording. The VCR tape was filed. Usually the console operator also brought the sample log to the rosette room and served as the *sample cop*.

1.5. CTD Laboratory Calibration Procedures

Pre-cruise laboratory calibrations of the CTD pressure and temperature sensors were used to generate tables of corrections applied by the CTD data acquisition and processing software at sea. These laboratory calibrations were also performed post-cruise.

Pressure and temperature calibrations were performed on CTD #1 at the ODF Calibration Facility (La Jolla). The pre-cruise calibration was done in May 1993 before the start of the expediton, and the post-cruise calibration was done in October 1993.

The CTD pressure transducer was calibrated in a temperature-controlled water bath to a Ruska Model 2400 Piston Gauge pressure reference. Calibration curves were measured at 0.01, 11.74 and 31.22°C to 2 maximum loading pressures (2775 and 6080 db) pre-cruise, and at 1.62 and 32.13°C to 2 maximum loading pressures (1400 and 6080 db) post-cruise. Figure 1.5.0 summarizes the laboratory pressure calibration performed in May 1993 and Figure 1.5.1 summarizes the pressure calibrations done in October 1993.

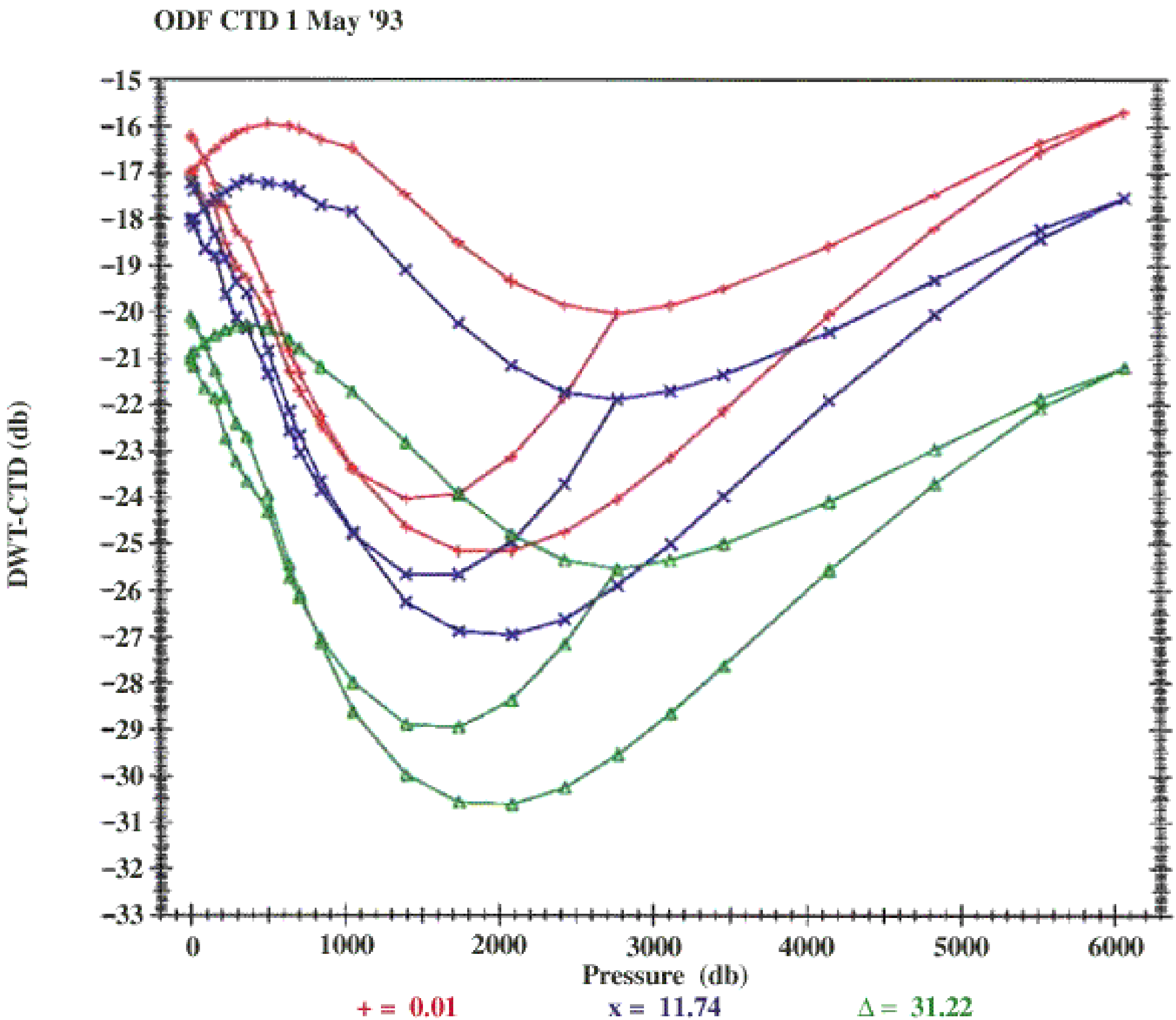


Figure 1.5.0 Pressure calibration for ODF CTD #1, May 1993.

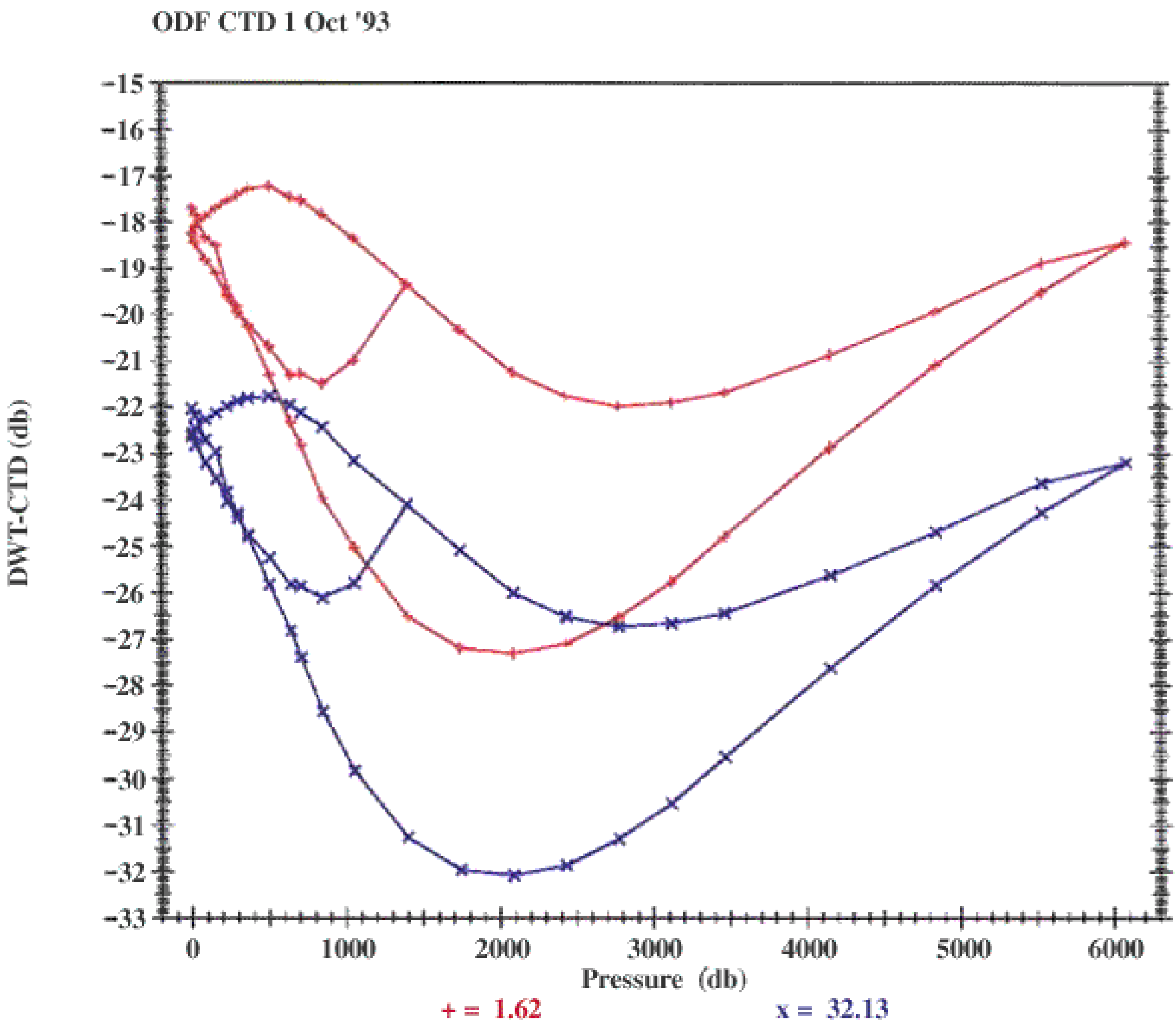


Figure 1.5.1 Pressure calibration for ODF CTD #1, October 1993.

Additionally, dynamic thermal-response step tests were conducted on the pressure transducer to calibrate dynamic thermal effects.

CTD PRT temperatures were calibrated to an NBIS ATB-1250 resistance bridge and Rosemount standard PRT in a temperature-controlled bath. The primary CTD temperature was offset by ~1.5°C to avoid the 0-point discontinuity inherent in the internal digitizing circuitry. Figures 1.5.3-1.5.4 summarize the laboratory calibrations performed on the primary PRT.

These laboratory temperature calibrations are referenced to the ITS-90 standard. Calibration coefficients were converted to the IPTS-68 standard because calculated parameters, including salinity and density, are currently defined in terms of that standard.

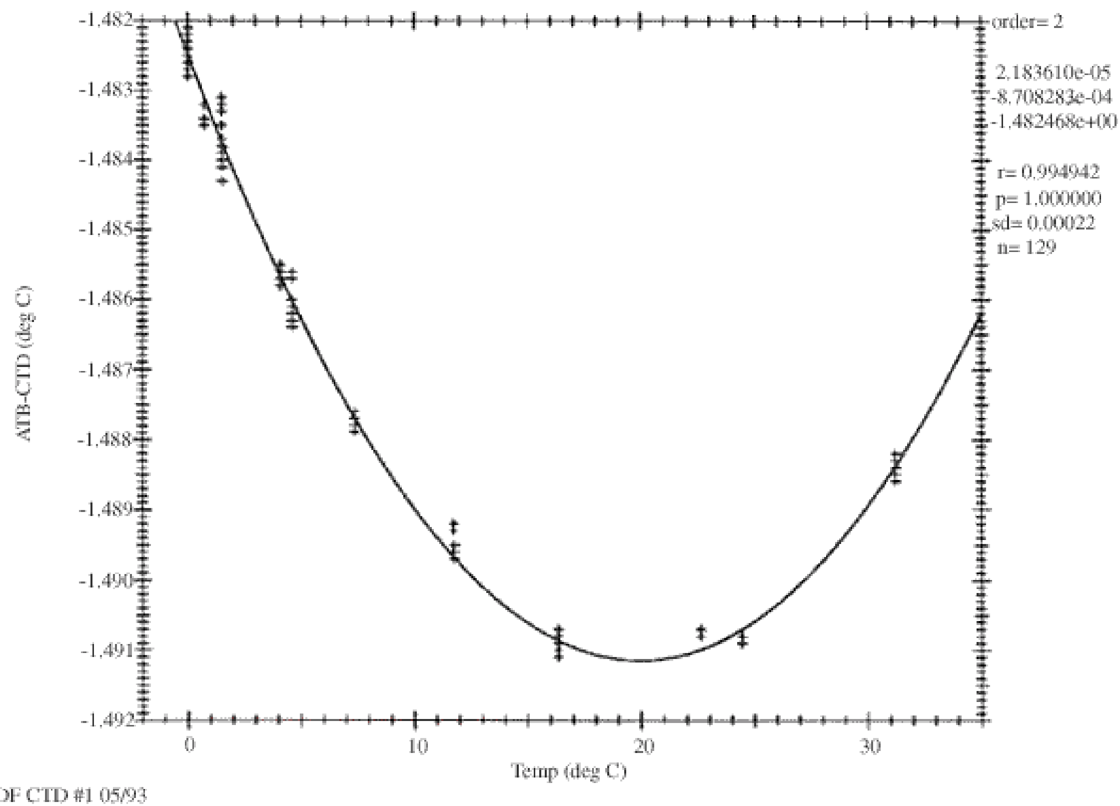


Figure 1.5.3 Temperature calibration for ODF CTD #1, May 1993.

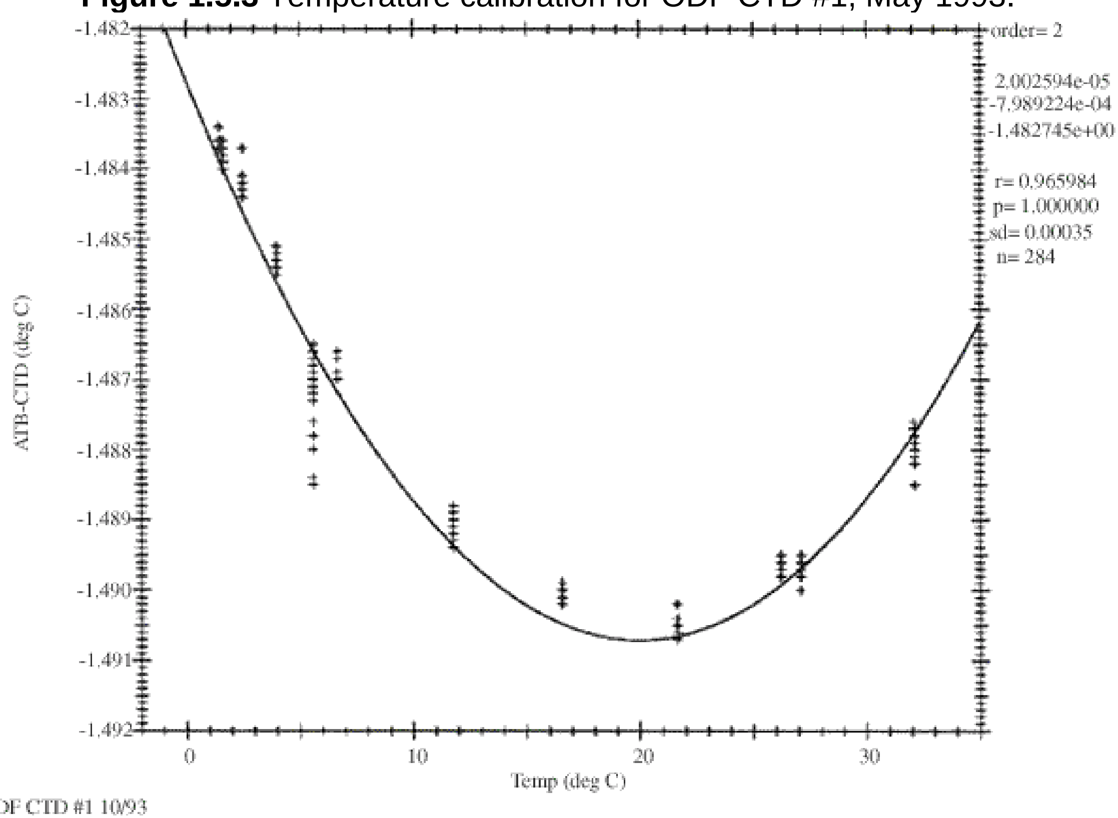


Figure 1.5.4 Temperature calibration for ODF CTD #1, October 1993.

1.6. CTD Calibration Procedures

This cruise was the first of 2 consecutive Pacific Ocean cruises for this CTD. Transfer standards and redundant sensors were used as calibration checks while at sea. An FSI secondary pressure reference was used as a pressure calibration transfer standard. An FSI PRT sensor was deployed as a second temperature channel and compared with the primary PRT channel on most casts.

The secondary PRT sensor did not exhibit any appreciable drift during these expeditions. There was a constant offset maintained between the 2 PRTs throughout this leg. Figure 1.6.0 summarizes the comparison between the primary and secondary PRT channels. The response times of the sensors were first matched, then the temperatures compared for a series of standard depths from each CTD down-cast.

CTD conductivity and dissolved O_2 were calibrated to in-situ check samples collected during each rosette cast. Based on the stability of the conductivity calibration, there were no significant shifts in the CTD pressure or temperature.

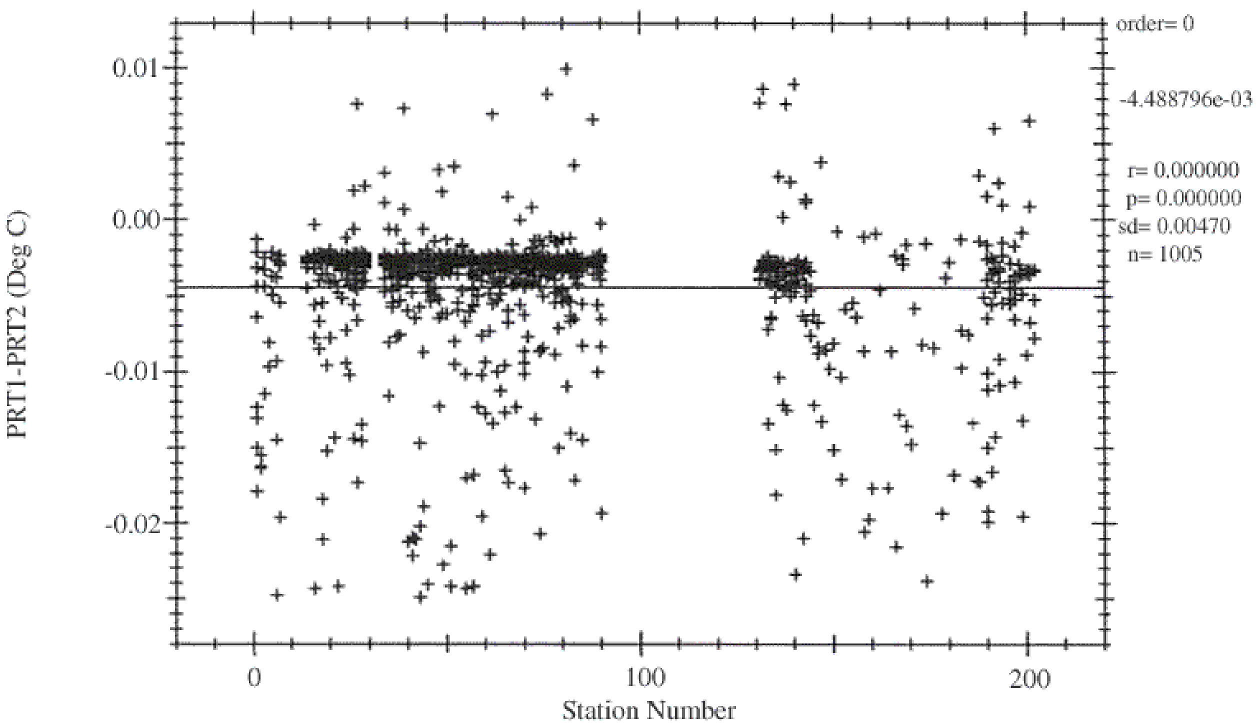


Figure 1.6.0 Comparison between the primary and secondary PRT channels.

CTD Pressure and Temperature

The final pressure and temperature calibrations were determined during post-cruise processing. Over 6000 db, there was a 1.5 db slope change between the pre- and post-cruise cold "deep" pressure laboratory calibrations, as well as an ~1.5 db offset between the 2 sets of pressure calibrations (pre- and post). After analyzing these 2 sets of calibrations, a decision was made to generate new tables of corrections based on averaging the data from both sets of pressure calibrations. These new corrections, generated by this new averaged calibration, were then reapplied to the data set for the cruise. Another reason to reapply the corrections to the block-averaged data was because the pressure model used had been further refined to more accurately apply the thermal shock correction. Figure 1.6.1 summarizes the average of the pre/post laboratory pressure calibrations.

The primary temperature sensor (Rosemount Model 171BJ Serial No. 14304) laboratory calibration shows essentially the same curve pre- and post- cruise, with at most a .0004°C shift in the range of 10-27°C; colder and warmer than that range, the curves are essentially identical. It was therefore decided to stay with the pre-cruise PRT #1 correction for this data set.

The secondary temperature sensor (FSI Model OTM-D212 Serial No. 1320) laboratory calibrations pre- and post-cruise showed some differences, but the same temperature ranges were not measured and these FSI sensors show a greater amount of variability. There did not appear to be any major shift, perhaps an ~1 millidegree shift in the range of 1-20°C.

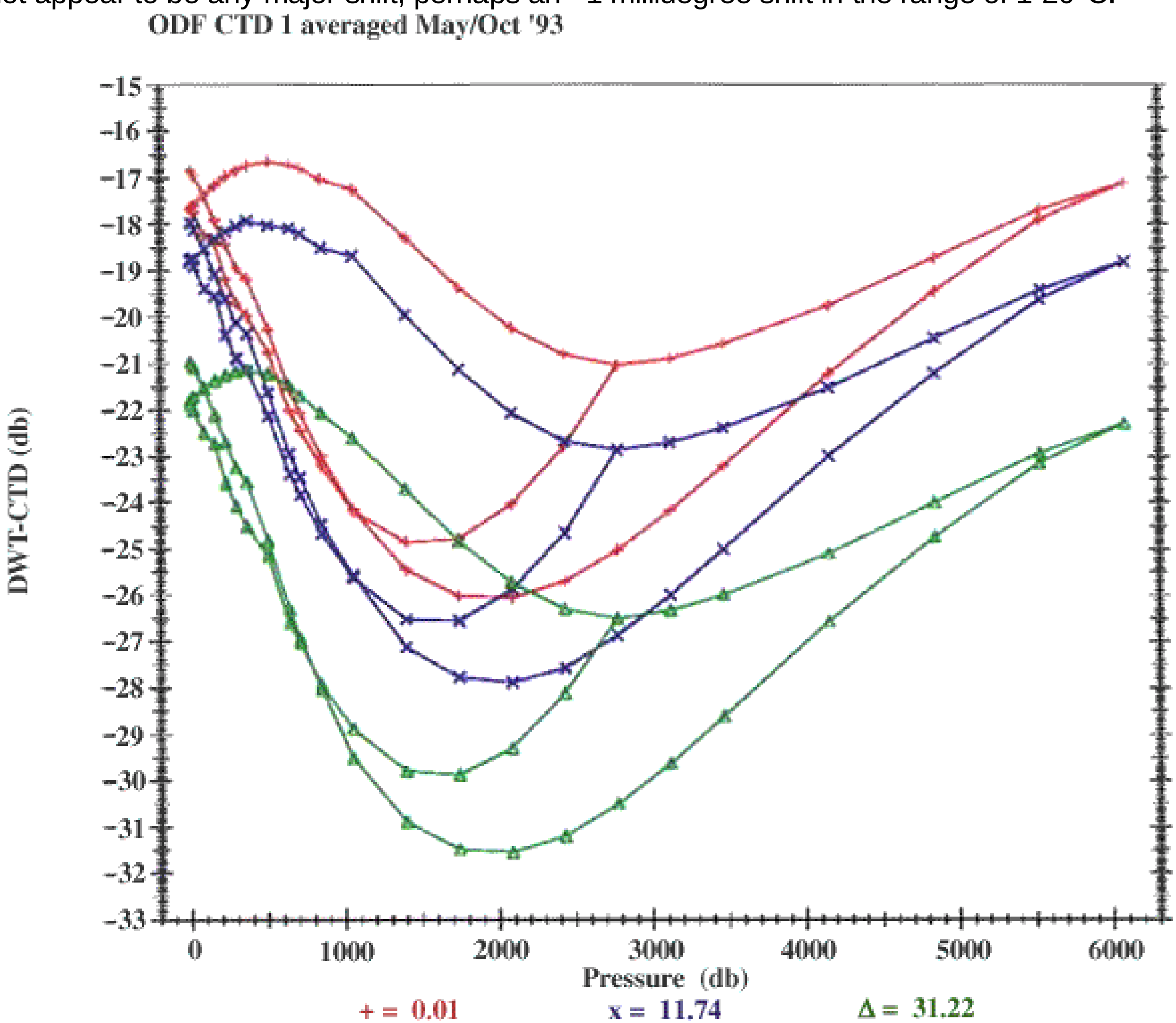


Figure 1.6.1 Pressure calibration for ODF CTD #1, averaged May/Oct 1993.

Conductivity

The CTD rosette trip pressure and temperature were used with the bottle salinity to calculate a bottle conductivity. Differences between the bottle and CTD conductivities were then used to derive a conductivity correction as a linear function of conductivity.

Cast-by-cast comparisons had shown only minor conductivity sensor offset shifts, and no sensor slope changes. Conductivity differences were fit to CTD conductivity for all casts to determine the mean conductivity slope. The mean conductivity slope correction is summarized in figure 1.6.1.

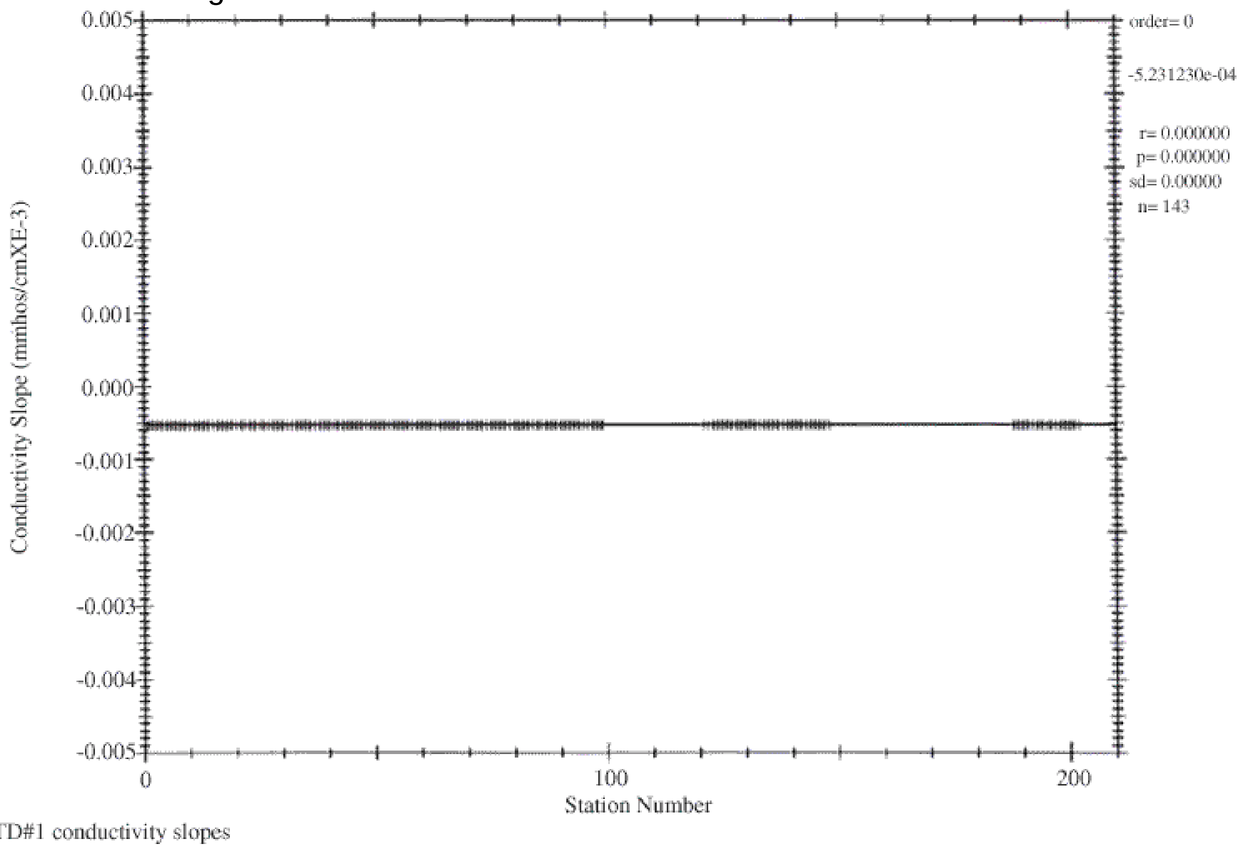


Figure 1.6.1 Mean conductivity slope correction.

The mean conductivity slope (-0.000523123 mmhos/cm) was used for all casts.

Residual CTD #1 conductivity offset values were calculated after applying the conductivity slopes. The conductivity offsets were determined for each cast from the deepest bottle conductivities and then fit as a function of station number by groups. Smoothed offsets were applied to CTD conductivities in 5 station groups: 001-056, 057-067, 068-097, 098-189 and 190-202. The conductivity sensor was cleaned after stations 056 and 067. Stations 098-120 were shallow (maxp less than 600 db) and stations 146-189 were also shallow (mostly less than 200 db) so the smoothed conductivity offset determined from the deep group of stations 122-145 was applied to all these shallow casts. The group of stations 190-202 were mid-range, varying between 1010 and 2700 db. Figure 1.6.2 summarizes the final applied conductivity offsets by station number.

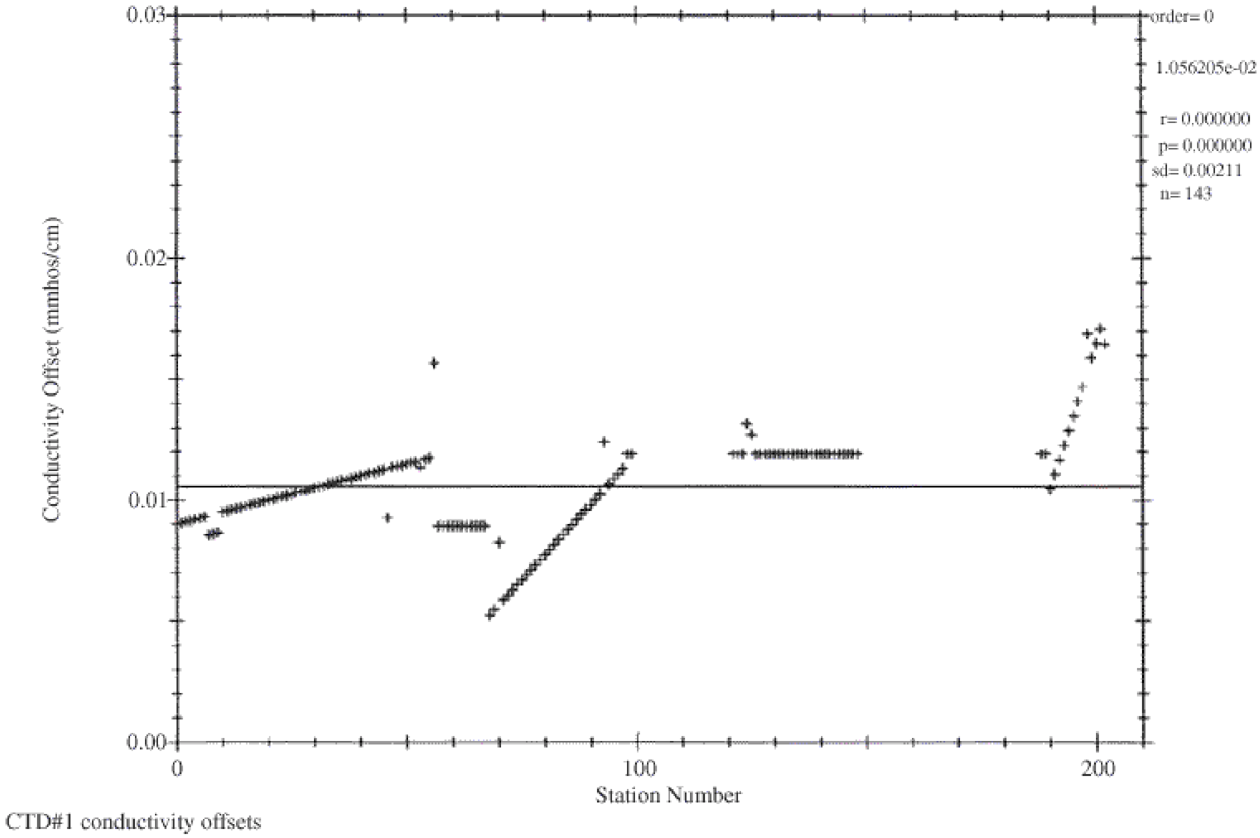


Figure 1.6.2 CTD conductivity offsets by station number.

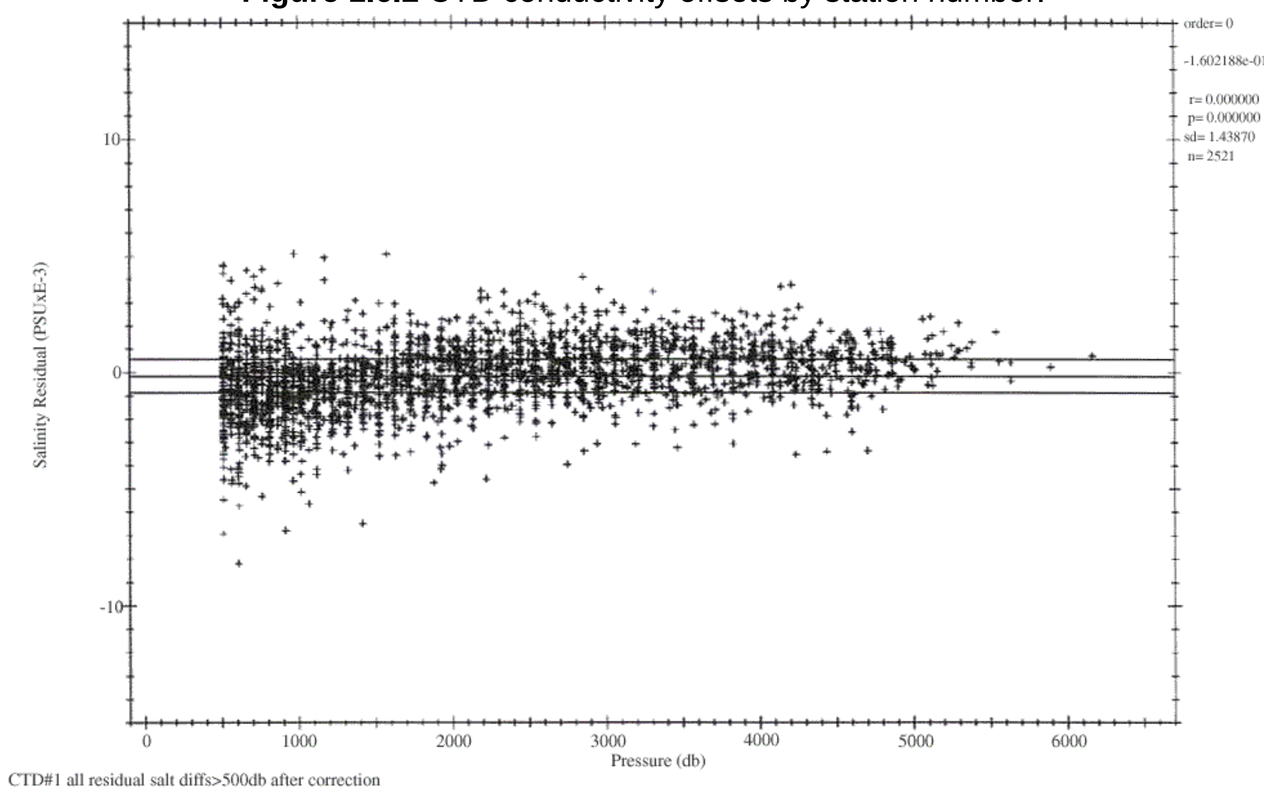


Figure 1.6.3 Salinity residual differences vs pressure (after correction).

Figures 1.6.3, 1.6.4 and 1.6.5 summarize the residual differences between bottle and CTD salinities after applying the conductivity correction.

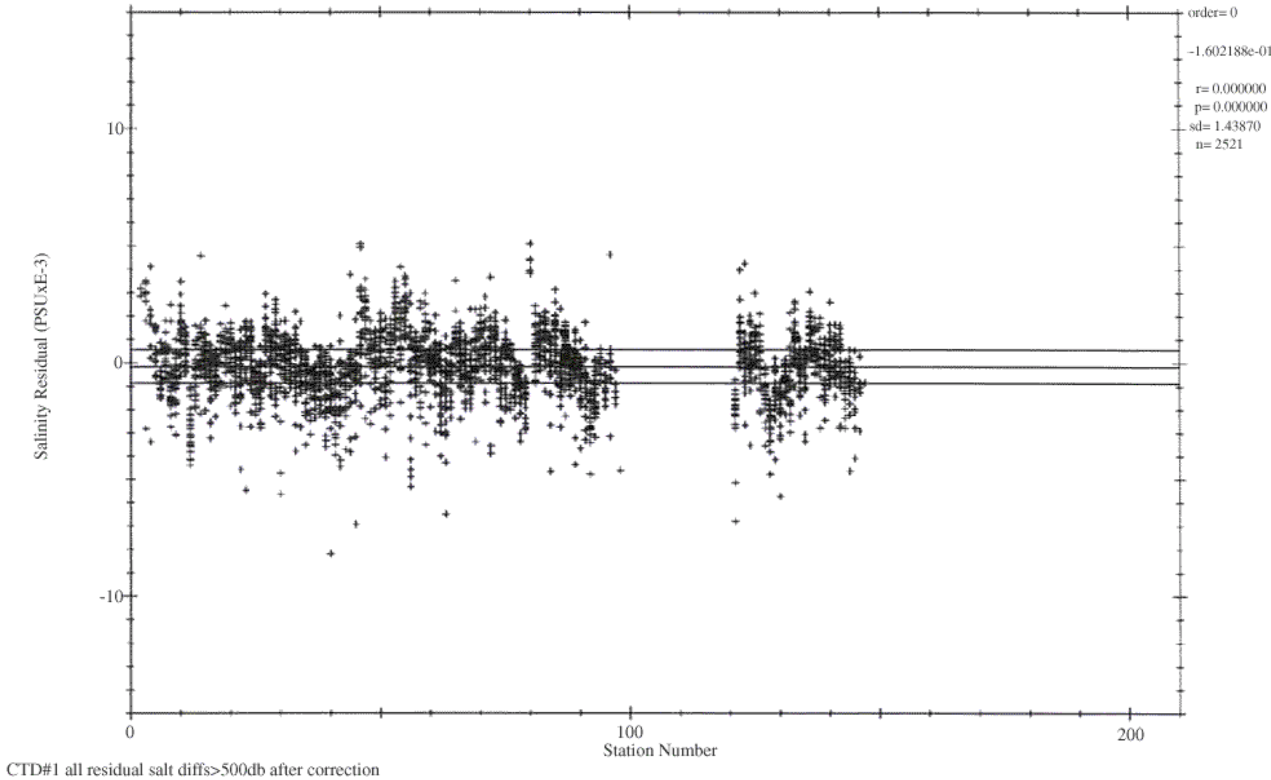


Figure 1.6.4 Salinity residual differences vs station # (after correction).

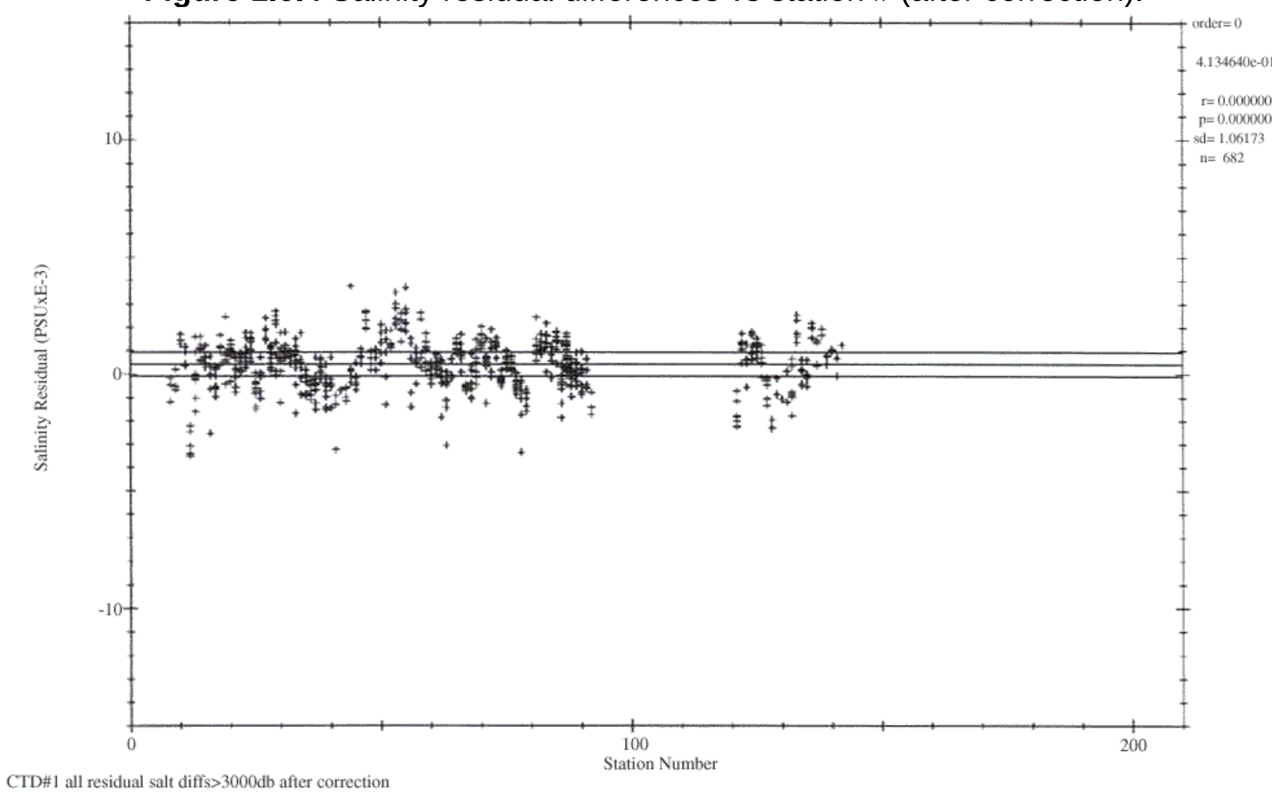


Figure 1.6.5 Deep salinity residual differences vs station # (after correction).

The CTD conductivity calibration represents a best estimate of the conductivity field throughout the water column. Note that the CTD calibration was not fit from the bottle conductivities cast-by-cast. Also, Some offsets were manually re-adjusted to account for discontinuous shifts in the conductivity transducer response, or to insure a consistent deep T-S relationship from station to station. The conductivity cell on this CTD proved extremely stable as demonstrated by the constant calibration slope and offsets that could easily be fit by station groups.

3σ from the mean residual in Figures 1.6.4 and 1.6.5, or ±0.004 PSU for all salinities and ±0.001 PSU for deep salinities represents the limit of repeatability of the bottle salinities (Autosal, rosette, operators and samplers). This limit agrees with station overlays of deep T-S. Within a cast (a single salinometer run), the precision of bottle salinities appears to exceed 0.001 PSU. The precision of the CTD salinities appears to exceed 0.0005 PSU.

CTD Dissolved Oxygen

There are a number of problems with the response characteristics of the Sensormedics O_2 sensor used in the NBIS Mark III CTD, the major ones being a secondary thermal response and a sensitivity to profiling velocity. Because of these problems, CTD rosette trip data cannot be directly calibrated to O_2 check samples. Instead, down-cast CTD O_2 data are derived by matching the up-cast rosette trips along isopycnal surfaces. The differences between CTD O_2 data modeled from these derived values and check samples are then minimized using a non-linear least-squares fitting procedure. Figures 1.6.6 and 1.6.7 show the residual differences between the corrected CTD O_2 and the bottle O_2 (ml/l) for each station.

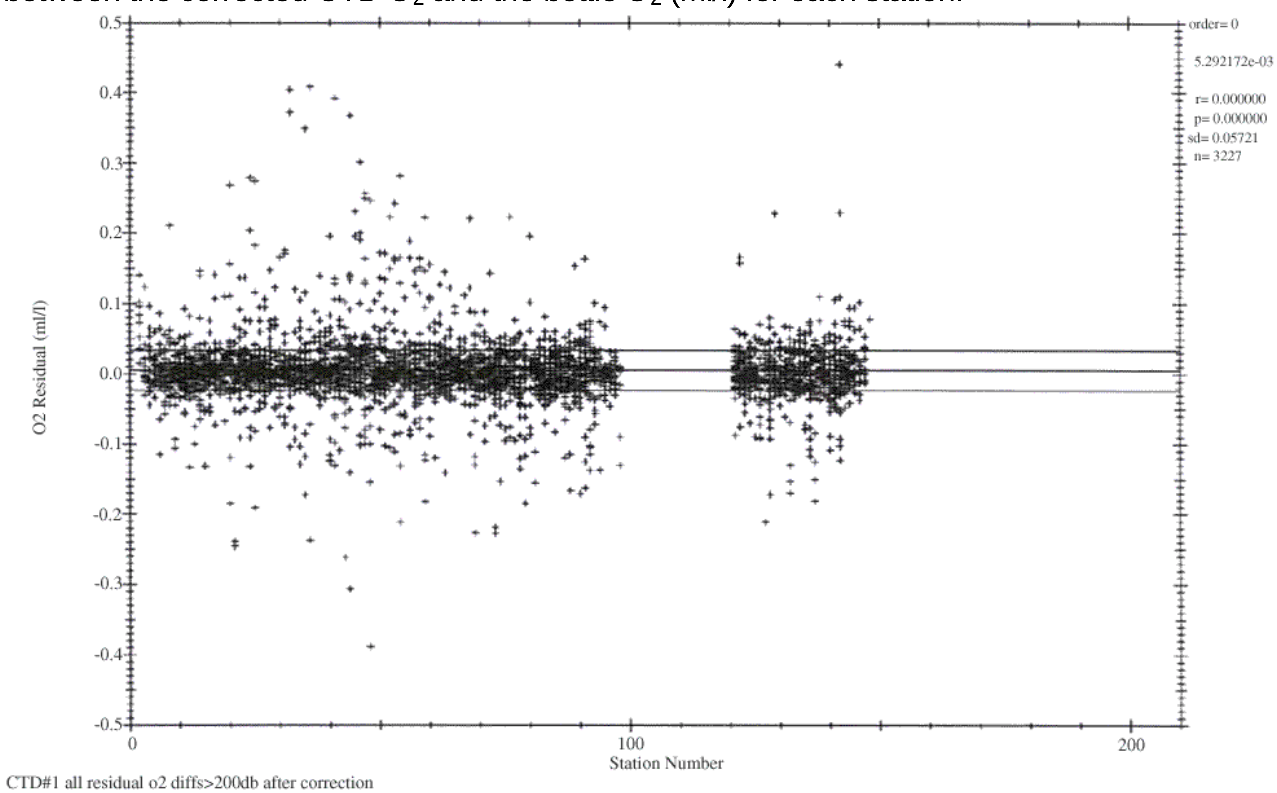


Figure 1.6.6 O_2 residual differences vs station # (after correction).

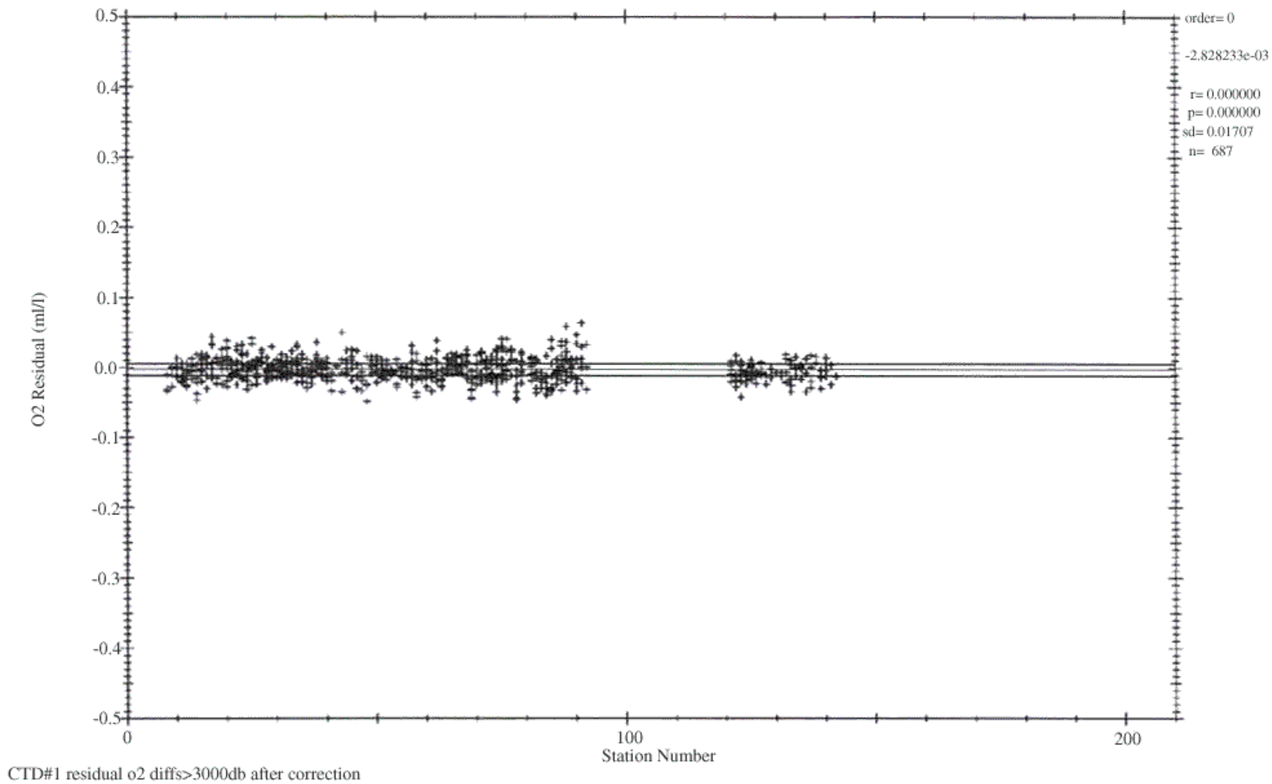


Figure 1.6.7 O_2 residual differences (>3000db).

Note that the mean of the differences is not zero, because the O_2 values are weighted by pressure before fitting. The standard deviations of 0.05 ml/l for all oxygens and 0.03 ml/l for deep oxygens are only intended as metrics of the goodness of the fits. ODF makes no claims regarding the precision or accuracy of CTD dissolved O_2 data.

The general form of the ODF O_2 conversion equation follows Brown and Morrison [Brow78] and Millard [Mill82], [Owen85]. ODF does not use a digitized O_2 sensor temperature to model the secondary thermal response but instead models membrane and sensor temperatures by low-pass filtering the PRT temperature. *In-situ* pressure and temperature are filtered to match the sensor response. Time-constants for the pressure response τ_p, and two temperature responses τ_{Ts} and τ_{Tf} are fitting parameters. The sensor current, or O_c, gradient is approximated by low-pass filtering 1st-order O_c differences. This term attempts to correct for reduction of species other than O_2 at the cathode. The time-constant for this filter, τ_{og}, is a fitting parameter. Oxygen partial-pressure is then calculated:

$$O_{pp}=[c_1 O_c+c_2] f_{sat}(S,T,P) \cdot e^{(c3Pl+c4Tf+c5Ts+c6(dOc/dt))} \qquad (1.6.0)$$

where:

O_{pp} = Dissolved O_2 partial-pressure in atmospheres (atm);
O_c = Sensor current (μamps);
$f_{sat}(S,T,P)$ = O_2 saturation partial-pressure at S,T,P (atm);
S = Salinity at O2 response-time (PSUs);
T = Temperature at O2 response-time (°C);
P = Pressure at O2 response-time (decibars);

P_l = Low-pass filtered pressure (decibars);
T_f = Fast low-pass filtered temperature (°C);
T_s = Slow low-pass filtered temperature (°C);
dO_c/dt = Sensor current gradient (μamps/secs).

1.7. CTD Data Processing

ODF CTD processing software consists of over 30 programs running under the Unix operating system. The initial CTD processing program (ctdba) is used either in real-time or with existing raw data sets to:

- Convert raw CTD scans into scaled engineering units, and assign the data to logical channels;
- Filter specific channels according to specified filtering criteria;
- Apply sensor or instrument-specific response-correction models;
- Provide periodic averages of the channels corresponding to the output time-series interval; and
- Store the output time-series in a CTD-independent format.

Once the CTD data are reduced to a standard-format time-series, they can be manipulated in a number of various ways. Channels can be additionally filtered. The time-series can be split up into shorter time-series or pasted together to form longer time-series. A time-series can be transformed into a pressure-series, or a different interval time-series. For temperature, conductivity and oxygen, calibration corrections to the series are maintained in separate files and are applied whenever the data are accessed. The pressure calibration corrections are applied during reduction of the data to time-series.

ODF data acquisition software acquired and processed the CTD data in real- time, providing calibrated, processed data for interactive plotting and reporting during a cast. The 25 hz data from the CTD were filtered, response-corrected and averaged to a 2 hz (0.5 seconds) time-series. Sensor correction and calibration models were applied to pressure, temperature, conductivity and O_2. Rosette trip data were extracted from this time-series in response to trip initiation and confirmation signals. The calibrated 2 hz time-series data were stored on disk (as were the 25 hz raw data) and were available in real-time for reporting and graphical display. At the end of the cast, various consistency and calibration checks were performed, and a 2.0 db pressure-series of the down-cast was generated and subsequently used for reports and plots.

CTD plots generated automatically at the completion of deployment were checked daily for potential problems. The two PRT temperature sensors were inter-calibrated and checked for sensor drift. The CTD conductivity sensor was monitored by comparing CTD values to check-sample conductivities and by deep T-S comparisons with adjacent stations. The CTD dissolved O_2 sensor was calibrated to check-sample data.

A few casts exhibited conductivity offsets due to biological or particulate artifacts. Sometimes casts are subject to noise in 1 or more channels. In these cases the 2 hz time-series were additionally filtered, using a spike-removal filter that replaced points exceeding a specified multiple of the standard deviation least-squares polynomial fit of specified order of segments of the data. The filtered points were replaced by the filtering polynomial value.

Density inversions can appear in high-gradient regions. Detailed examination of the raw data shows significant mixing occurring in these areas because of ship roll. In order to minimize these inversions, a ship-roll filter was applied to most casts during pressure-sequencing to disallow pressure reversals. Pressure intervals with no time-series data can optionally be filled by double-parabolic interpolation.

When the down-cast CTD data have excessive noise, gaps or offsets, the up-cast data are used instead. CTD data from down- and up-casts are not mixed together in the pressure-series data because they do not represent identical water columns (due to ship movement, wire angles, etc.).

Table 1.7.0 provides a list of CTD casts requiring special attention.

Cast	Problem/Comment	Solution
007/01	CTD O2 offset 2993 db	offset.
011/01	Salt offset 650-658 db	offset.
022/01	Retermination after cast	
024/01	Power outage down-cast	filtered-CTD O2 questionable 4902 db to bottom.
027/01	Power outage down-cast	filtered-CTD O2 questionable 5214 db to bottom.
042/01	2.9 min pause @ 3098 db-possible feature there in both dn/up & all parameters	no action.
044/01	Salt offset 3070-3186 db	offset.
047/01	Salt offset 1852-4046 db	offset.
057/01	Cond cell cleaned after cast; shift in cond offset.	
059/01	Salt offset 1918-1945 db	offset.
060/01	CTD O2 feature ~3500 db both dn/up	no action.
066/01	No surface bottle O2	no action.
068/01	Cond cell cleaned after cast; shift in cond offset	
070/01	Salt offset 1525-1588 db/power outage down-cast	offset/filtered & offset.
073/01	CTD O2 bad top 130 db; retermination after cast	no action.
080/01	Numerous salt offsets due to biological matter	filtered/chopped off bottom 112 db.
087/02	Salt offset 1670-2008 db/no discrete O2	offset/used CTD O2 fit from 087/01.
091/01	1.8 min pause @ 3980 db	no action-CTD O2 questionable 3978-3988 db.
092/01	0.46 min pause @ 3570 db	no action-CTD O2 questionable 3568-3584 db.
093/01	CTD O2 feature ~2800 db both dn/up	no action.
120/01	CTD hit bottom; no apparent cond sensor shift	
123/01	Salt offset 1206-1366 db	offset.
188/01	Cast maxp < 200 db - CTD O2 bad top 40 db	no action.
190/02	Numerous down-cast cond drop-outs	up-cast used.
195/01	Impossible to get CTD O2 to fit	blanked out CTD O2 data.
196/01	Salt offset 38-46 db	filtered.

Table 1.7.0 Tabulation of atypical CTD casts.

1.8. Bottle Sampling

At the end of each rosette deployment water samples were drawn from the bottles in the following order:

- CFCs;
- Helium;
- Oxygen;
- Total CO2;
- Alkalinity;
- AMS C14;
- Tritium;
- Nutrients;
- Salinity.

The correspondence between individual sample containers and the rosette bottle from which the sample was drawn was recorded on the sample log for the cast. This log also included any comments or anomalous conditions noted about the rosette and bottles. One member of the sampling team was designated the *sample cop*, whose sole responsibility was to maintain this log and insure that sampling progressed in proper drawing order.

Normal sampling practice included opening the drain valve before opening the air vent on the bottle, indicating an air leak if water escaped. This observation together with other diagnostic comments (e.g., "lanyard caught in lid", "valve left open") that might later prove useful in determining sample integrity were routinely noted on the sample log.

Drawing oxygen samples also involved taking the sample draw temperature from the bottle. The temperature was noted on the sample log and was sometimes useful in determining leaking or mis-tripped bottles.

Once individual samples had been drawn and properly prepared, they were distributed to their respective laboratories for analysis. Oxygen, nutrients and salinity analyses were performed on computer-assisted (PC) analytical equipment networked to Sun SPARCStations for centralized data analysis. The analyst for a specific property was responsible for insuring that their results updated the cruise database.

1.9. Bottle Data Processing

The first stage of bottle data processing consisted of verifying and validating individual samples, and checking the sample log (the sample inventory) for consistency. At this stage, bottle tripping problems were usually resolved, sometimes resulting in changes to the pressure, temperature and other CTD properties associated with the bottle. Note that the rosette bottle number was the primary identification for all samples taken from the bottle, as well as for the CTD data associated with the bottle. All CTD trips were retained (whether confirmed or not), so resolving bottle tripping problems simply consisted of assigning the right rosette bottle number to the right CTD trip level.

Diagnostic comments from the sample log were then translated into preliminary WOCE quality codes, together with appropriate comments. Each code indicating a potential problem was investigated.

The second stage of processing began once all the samples for a cast had been accounted for. All samples for bottles suspected of leaking were checked to see if the property was consistent with the profile for the cast, with adjacent stations, and where applicable, with the CTD data. All comments from the analysts were examined and turned into appropriate WHP water sample codes. Oxygen flask numbers were verified, as each flask is individually calibrated and significantly affects the calculated O_2 concentration.

The third stage of processing continued throughout the cruise and until the data set is considered "final". Various property-property plots and vertical sections were examined for both consistency within a cast and consistency with adjacent stations. In conjunction with this process the analysts would review and sometimes revise their data as additional calibration or diagnostic results became available. Assignment of a WHP water sample code to an anomalous sample value was typically achieved through consensus, usually also involving one of the chief scientists.

WHP water bottle quality flags were assigned with the following additional interpretations:

3	An air leak large enough to produce an observable effect on a sample is identified by a code of 3 on the bottle and a code of 4 on the oxygen. (Small air leaks may have no observable effect, or may only affect gas samples.)
4	Bottles tripped at other than the intended depth were assigned a code of 4. There may be no problems with the associated water sample data.

WHP water sample quality flags were assigned using the following criteria:

1	The sample for this measurement was drawn from a bottle, but the results of the analysis were not (yet) received.
2	Acceptable measurement.
3	Questionable measurement. The data did not fit the station profile or adjacent station comparisons (or possibly CTD data comparisons). No notes from the analyst indicated a problem. The data could be correct, but are open to interpretation.
4	Bad measurement. Does not fit the station profile, adjacent stations or CTD data. There were analytical notes indicating a problem, but data values were reported. Sampling and analytical errors were also coded as 4.
5	Not reported. There should always be a reason associated with a code of 5, usually that the sample was lost, contaminated or rendered unusable.
9	The sample for this measurement was not drawn.

WHP water sample quality flags were assigned to the CTDSAL (CTD salinity) parameter as follows:

2	Acceptable measurement.
3	Questionable measurement. The data did not fit the bottle data, or there was a CTD conductivity calibration shift during the cast.
4	Bad measurement. The CTD data were determined to be unusable for calculating a salinity.
8	The CTD salinity was derived from the CTD down cast, matched on an isopycnal surface.

WHP water sample quality flags were assigned to the CTDOXY (CTD oxygen) parameter as follows:

2	Acceptable measurement.
4	Bad measurement. The CTD data were determined to be unusable for calculating a dissolved oxygen concentration.
5	Not reported. The CTD data could not be reported.
9	Not sampled. No operational dissolved oxygen sensor was present on this cast.

Note that all CTDOXY values were derived from the down cast data, matched to the up-cast along isopycnal surfaces. If the CTD salinity was footnoted as bad or questionable, the CTD oxygen is blank.

Table 1.9.0 and 1.9.1 shows the number of samples drawn and the number of times each WHP sample quality flag was assigned for each basic hydrographic property:

Rosette Samples Stations 1-99, 121-148							
	Reported	WHP Quality Codes					
	levels	1	2	3	4	5	9
Bottle	4343	0	4090	14	228	0	11
CTDSalt	4343	0	4258	0	85	0	0
CTDOxy	4260	0	4227	33	0	0	83
Salinity	4324	0	4264	12	48	6	13
Oxygen	4292	0	4272	1	19	4	47
Silicate	4293	0	4238	40	15	0	50
Nitrate	4293	0	4272	6	15	0	50
Nitrite	4006	0	3992	0	14	287	50
Phosphate	4293	0	4201	5	87	0	50

Table 1.9.0 Frequency of WHP quality flag assignments.

Large Volume Samples Stations 10,28,39,48,58,68,78,86,132,141										
	Reported levels	WHP Quality Codes 1	2	3	4	5	6	7	8	9
Bottle	360	0	353	5	0	0	0	0	0	2
Salinity	358	0	345	12	1	0	0	0	0	2
Silicate	358	0	320	37	1	0	0	0	0	2
Nitrate	358	0	0	0	358	0	0	0	0	2
Nitrite	322	0	0	0	322	36	0	0	0	2
Phosphate	358	0	0	0	358	0	0	0	0	2
Pressure	360	0	360	0	0	0	0	0	0	0
Temperature	352	0	348	4	0	8	0	0	0	0

Table 1.9.1 Frequency of WHP LVS quality flag assignments.

Additionally, all WHP water bottle/sample quality code comments are presented in Appendices C and D.

1.10. Pressure and Temperatures

All pressures and temperatures for the bottle data tabulations on the rosette casts were obtained by averaging CTD data for a brief interval at the time the bottle was closed on the rosette, then correcting the data based on CTD laboratory calibrations.

LVS pressures and temperatures were calculated from deep-sea reversing thermometer (DSRT) readings. Each DSRT rack normally held 2 protected (temperature) thermometers and 1 unprotected (pressure) thermometer. Thermometers were read by two people, each attempting to read a precision equal to one tenth of the thermometer etching interval. Thus, a thermometer etched at 0.05 degree intervals would be read to the nearest 0.005 degrees. Each temperature value reported on the LVS cast is therefore calculated from the average of four readings, provided both protected thermometers function normally. The pressure is verified by comparison with the calculation of pressure determined by wireout. The pressure from the thermometer is fitted by a polynomial equation which incorporates the wireout and wire angle.

Calibration of the thermometers are performed in ODF's calibration facility depending on the age of the thermometer and within two years of the expedition.

The temperatures are based on the International Temperature Scale of 1990.

1.11. Salinity Analysis

Salinity samples were drawn into 200 ml Kimax high alumina borosilicate bottles after 3 rinses, and were sealed with custom-made plastic insert thimbles and Nalgene screw caps. This assembly provides very low container dissolution and sample evaporation. As loose inserts were found, they were replaced to ensure a continued airtight seal. Salinity was determined after a box of samples had equilibrated to laboratory temperature, usually within 8-12 hours of collection. The draw time and equilibration time, as well as per-sample analysis time and temperature were logged.

Two Guildline Autosal Model 8400A salinometers (55-654 and 57-396) were used to measure salinities. These were located in a temperature-controlled laboratory. The salinometers were modified by ODF and contained interfaces for computer-aided measurement. A computer (PC) prompted the analyst for control functions (changing sample, flushing) while it made continuous measurements and logged results. The salinometer cell was flushed until successive readings met software criteria for consistency, then two successive measurements were made and averaged for a final result.

The salinometer was standardized for each cast with IAPSO Standard Seawater (SSW) Batch P-122, using at least one fresh vial per cast. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 PSU relative to the particular Standard Seawater batch used. PSS-78 salinity [UNES81] was then calculated for each sample from the measured conductivity ratios, and the results merged with the cruise database.

Salinometer 55-654 was used on stations 001, 002 and 013-202. Salinometer 57-396 was used on stations 003-012.

4324 salinity measurements were made from the rosette stations; 358 measurements were made from the large volume stations. 376 vials of standard water were used. The temperature stability of the laboratory used to make the measurements was acceptable (usually within 4°C of the salinometer bath temperature). There were no substantial problems noted with the analyses. The salinities were used to calibrate the CTD conductivity sensor.

1.12. Oxygen Analysis

Samples were collected for dissolved oxygen analyses soon after the rosette sampler was brought on board and after CFC and helium were drawn. Nominal 125 ml volume-calibrated iodine flasks were rinsed twice with minimal agitation, then filled via a drawing tube, and allowed to overflow for at least 3 flask volumes. The sample temperature was measured with a small platinum resistance thermometer embedded in the drawing tube. Draw temperatures were very useful in detecting possible bad trips even as samples were being drawn. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice to assure thorough dispersion of the $MnO(OH)_2$ precipitate. They were shaken once immediately after drawing, and then again after 20 minutes. The samples were analyzed within 4-36 hours of collection.

Dissolved oxygen analyses were performed with an SIO-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365 nm wavelength ultra-violet light. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 ml buret. ODF uses a whole-bottle modified-Winkler titration following the technique of Carpenter [Carp65] with modifications by Culberson *et. al* [Culb91], but with higher concentrations of potassium iodate standard (approximately 0.012N) and thiosulfate solution (50 gm/l). Standard solutions prepared from pre-weighed potassium iodate crystals were run at the beginning of each session of analyses, which typically included from 1 to 3 stations. Several standards were made up during the cruise and compared to assure that the results were reproducible, and to preclude the possibility of a weighing error. Reagent/distilled water blanks were determined to account for oxidizing or reducing materials in the reagents. The auto-titrator generally performed very well.

The samples were titrated and the data logged by the PC control software. The data were then used to update the cruise database on the Sun SPARCstations.

Thiosulfate normalities and blanks, calculated from each standardization and corrected to 20°C, were plotted versus time and were reviewed for possible problems. New thiosulfate normalities were recalculated after the blanks had been smoothed. These normalities were then smoothed, and the oxygen data were recalculated.

Oxygens were converted from milliliters per liter to micromoles per kilogram using the *in-situ* temperature. Ideally, for whole-bottle titrations, the conversion temperature should be the temperature of the water issuing from the bottle spigot. The sample temperatures were measured at the time the samples were drawn from the bottle, but were not used in the conversion from milliliters per liter to micromoles per kilogram because the software was not available. Aberrant drawing temperatures provided an additional flag indicating that a bottle may not have tripped properly. Measured sample temperatures from mid-deep water samples were about 4-7°C warmer than in-situ temperature. Had the conversion with the measured sample temperature been made, converted oxygen values would be about 0.08% higher for a 6°C warming (or about 0.2 µM/Kg for a 250 µM/Kg sample).

Oxygen flasks were calibrated gravimetrically with degassed deionized water (DIW) to determine flask volumes at ODF's chemistry laboratory. This is done once before using flasks for the first time and periodically thereafter when a suspect bottle volume is detected. All volumetric glassware used in preparing standards is calibrated as well as the 10 ml Dosimat buret used to dispense standard iodate solution.

Iodate standards are pre-weighed in ODF's chemistry laboratory to a nominal weight of 0.44xx grams and exact normality calculated at sea. Potassium iodate (KIO_3) is obtained from Johnson Matthey Chemical Co. and is reported by the supplier to be > 99.4% pure. All other reagents are "reagent grade" and are tested for levels of oxidizing and reducing impurities prior to use.

4292 oxygen measurements from the rosette stations were made. Oxygens were not drawn from the large volume stations. No major problems were encountered with the analyses. The oxygen data were used to calibrate the CTD dissolved O_2 sensor.

1.13. Nutrient Analysis

Nutrient samples were drawn into 45 ml high density polypropylene, narrow mouth, screw-capped centrifuge tubes which were rinsed three times before filling. Standardizations were performed at the beginning and end of each group of analyses (one cast, usually 36 samples) with a set of an intermediate concentration standard prepared for each run from secondary standards. These secondary standards were in turn prepared aboard ship by dilution from dry, pre-weighed primary standards. Sets of 5-6 different concentrations of shipboard standards were analyzed periodically to determine the deviation from linearity as a function of concentration for each nutrient.

Nutrient analyses (phosphate, silicate, nitrate and nitrite) were performed on an ODF-modified 4 channel Technicon AutoAnalyzer II, generally within one hour of the cast. Occasionally some samples were refrigerated at 2 to 6°C for a maximum of 4 hours. The methods used are described by Gordon et al. [Atla71], [Hage72], [Gord92]. During the first part of the expedition, all peaks were logged manually. Later during the expedition, software was developed and implemented to interpret the colorimeter output from each of the four channels which were digitized and logged automatically by computer (PC), then split into absorbence peaks. All the runs were manually verified.

Silicate is analyzed using the technique of Armstrong *et al.* [Arms67]. Ammonium molybdate is added to a seawater sample to produce silicomolybdic acid which is then reduced to silicomolybdous acid (a blue compound) following the addition of stannous chloride. Tartaric acid is also added to impede PO_4 contamination. The sample is passed through a 15 mm flowcell and the absorbence measured at 820nm. ODF's methodology is known to be non-linear at high silicate concentrations (>120 µM); a correction for this non-linearity is applied in ODF's software.

Modifications of the Armstrong et al. [Arms67] techniques for nitrate and nitrite analysis are also used. The seawater sample for nitrate analysis is passed through a cadmium column where the nitrate is reduced to nitrite. Sulfanilamide is introduced, reacting with the nitrite, then N-(1-naphthyl)ethylenediamine dihydrochloride which couples to form a red azo dye. The reaction product is then passed through a 15 mm flowcell and the absorbence measured at 540 nm. The same technique is employed for nitrite analysis, except the cadmium column is not present, and a 50 mm flowcell is used.

Phosphate is analyzed using a modification of the Bernhardt and Wilhelms [Bern67] technique. Ammonium molybdate is added to the sample to produce phosphomolybdic acid, then reduced to phosphomolybdous acid (a blue compound) following the addition of dihydrazine sulfate. The reaction product is heated to ~55°C to enhance color development, then passed through a 50 mm flowcell and the absorbence measured at 820 nm.

Nutrients reported in micromoles per kilogram were converted from micromoles per liter by dividing by sample density calculated at 1 atm pressure, *in-situ* salinity, and an assumed laboratory temperature of 25°C.

Na_2SiF_6, the silicate primary standard, is obtained from Fluka Chemical Company and Fisher Scientific and is reported by the suppliers to be >98% pure. Primary standards for nitrate (KNO_3), nitrite ($NaNO_2$), and phosphate (KH_2PO_4) are obtained from Johnson Matthey Chemical Co. and the supplier reports purities of 99.999%, 97%, and 99.999%, respectively.

4293 nutrient analyses from the rosette stations were performed. 358 nutrient analyses were performed on the large volume stations. However, these data should only be used as a check of the integrity of the Gerard barrels. The nitrate, phosphate and nitrite are coded "4", bad measurement, as an assurance that these samples will not be used for any other purpose. No major problems were encountered with the measurements. Some concern was expressed in the comparison with historical silicate data. The Chemistry Department at ODF has compared the batch of sodium fluorosilicate (silicate standard) that was sent on the P17N WOCE leg with silicate standards from three other manufacturers, as well as a different lot of silicate standard from the same manufacturer. Our findings indicate that the silicate standard used on the P17N WOCE leg was 0.6% lower than the mean silicate standard value in this comparison.

References

Arms67.

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Atla71.

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D. Acknowledgments

I wish to thank Captain Gomes, the crew of the R/V Thompson and the scientific personnel for making this a pleasant and scientifically successful cruise.

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F. WHPO Summary

Stations number 100 to 120 are nonWOCE stations. They are represented in the sum file to show the cruise was continuous. The data will not be available in WOCE format.

Several data files are associated with this report. They are the P17n.sum, 325021_1.hyd, 325021_1.csl and *.wct files. The 325021_1.sum file contains a summary of the location, time, type of parameters sampled, and other pertinent information regarding each hydrographic station. The 325021_1.hyd file contains the bottle data. The *.wct files are the ctd data for each station. The *.wct files are zipped into one file called 325021_1wct.zip. The P17n.csl file is a listing of ctd and calculated values at standard levels.

The following is a description of how the standard levels and calculated values were derived for the 325021_1.csl file:

Salinity, Temperature and Pressure: These three values were smoothed from the individual CTD files over the N uniformly increasing pressure levels using the following binomial filter-

$$t(j) = 0.25ti(j-1) + 0.5ti(j) + 0.25ti(j+1) \quad j=2....N-1$$

When a pressure level is represented in the *.csl file that is not contained within the ctd values, the value was linearly interpolated to the desired level after applying the binomial filtering.

Sigma-theta(SIG-TH:KG/M3), Sigma-2 (SIG-2: KG/M3), and Sigma-4(SIG-4: KG/M3): These values are calculated using the practical salinity scale (PSS-78) and the international equation of state for seawater (EOS-80) as described in the Unesco publication 44 at reference pressures of the surface for SIG-TH; 2000 dbars for Sigma-2; and 4000 dbars for Sigma-4.

Gradient Potential Temperature (GRD-PT: C/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the interval. The interval being the smallest of the two differences between the standard level and the two closest values. The slope is first determined using CTD temperature and then the adiabatic lapse rate is subtracted to obtain the gradient potential temperature. Equations and Fortran routines are described in Unesco publication 44.

Gradient Salinity (GRD-S: 1/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the standard level and the two closes values. Equations and Fortran routines are described in Unesco publication 44.

Potential Vorticity (POT-V: 1/ms 10-11) is calculated as the vertical component ignoring contributions due to relative vorticity, i.e. pv=fN2/g, where f is the coriolius parameter, N is the buoyancy frequency (data expressed as radius/sec), and g is the local acceleration of gravity.

Buoyancy Frequency (B-V: cph) is calculated using the adiabatic leveling method, Fofonoff (1985) and Millard, Owens and Fofonoff (1990). Equations and Fortran routines are described in Unesco publication 44.

Potential Energy (PE: J/M2: 10-5) and Dynamic Height (DYN-HT: M) are calculated by integrating from 0 to the level of interest. Equations and Fortran routines are described in Unesco publication 44.

Neutral Density (GAMMA-N: KG/M3) is calculated with the program GAMMA-N (Jackett and McDougall) version 1.3 Nov. 94.

G. DQE Evaulations

CTD and hydrographic DQE by Micho Aoyama 8 April 1996

General:

The data quality of WOCE P17N CTD data (EXPOCODE: 325021/1) and the CTD salinity and oxygen found in dot sea file are examined. The individual 2 dbar profiles were observed in temperature, salinity and oxygen by comparing the profiles obtained at the nearby stations.

The CTD salinity and oxygen calibrations are examined using the water sample data file p17n.mka. DQE used the original water sample data flagged "2" only for the DQE work.

Details

1. CTD profiles

The temperature and salinity profiles generally look good. Since the data originator has done a pretty reliable work in evaluating their data, CTD data flagged "2-good" has a pretty good quality. Although the data originator has solved some CTD salinity offset problems well, DQE would like to complain of CTD conductivity offsets adapted by the data originator as described in the next section.

2. Evaluation of CTD calibrations to water samples:

2.1 Salinity calibration

The onboard calibration for salinity looks good in general. Standard deviation of Ds, Ds = CTD salinity in dot sea file - bottle salinity, is 0.00467 psu for all data and 0.00112 pss for deeper than 2000 dbar, respectively. The histogram of Ds for all depths shows a symmetric distribution (fig. 1). Since the larger difference are shallower layers, larger Ds disappeared in the histogram of Ds for deeper than 2000 dbar (fig. 2). DQE, however, observed the non-symmetric distribution of Ds in deep salinity fit. DQE observed that Ds vs. pressure plot shows a small bias of ca. -0.001 psu in the deeper than 2000 dbar, while it shows a small bias of 0.001 psu in the shallower than 1500 dbar (fig. 3). DQE also observed that the Ds in deep salinity fit shows a larger discontinuity at several stations as shown in fig 4 considering the accuracy and precision of CTD salinity for the WOCE one time survey standards for CTD measurements. The magnitude of the discontinuity and the stations are summarized in table 1 together with the problems recorded in table 1.7.0 in the cruise report;

Table 1: Summary of Ds offset larger than 0.002 psu.

stations	Ds offset	related comment in cruise report
a) between stn. 11 and 12	ca. 0.004 psu	sal. offset at stn. 11
b) between stn. 24 and 25	ca. 0.002 psu	power outage at stn. 24
c) between stn. 26 and 27	ca. -0.002 psu	power outage at stn. 27
d) between stn. 45 and 47	ca. -0.003 psu	sal. offset at stn. 47
e) between stn. 47 and 48	ca. 0.002 psu	sal. offset at stn. 47
f) between stn. 55 and 56	ca. 0.003 psu	no problem recorded
g) between stn. 79 and 81	ca. -0.002 psu	sal. offset at stn. 80
h) between stn. 121 and 122	ca. -0.003 psu	no problem recorded
i) between stn. 126 and 128	ca. 0.003 psu	no problem recorded
j) between stn. 131 and 133	ca. -0.002 psu	no problem recorded
k) between stn. 135 and 136	ca. -0.002 psu	no problem recorded

note: DQE marked a) through k) in fig. 4.

DQE thinks that something might have occurred to the conductivity sensor at the stations listed in above table. For an example, DQE thinks that the smoothed offset for the station group 068-097 is not in good fit. Then, Ds for stations 068-097 has a clear trend from -0.001 psu to 0.001 psu between 068 and 079, thereafter Ds for stations 080-097 shows clear trend from -0.001 psu to 0.001 psu again. DQE think this can be explained by the wrong estimation of the slope of the CTD conductivity offset due to the unsuitable station grouping. If the data originator will divide this station group of 068-097 into 2 station groups of 068-079 and 080-097 and apply new CTD conductivity offsets to CTD conductivities in new 2 station groups, the trend of Ds will be expected to be smaller remarkably.

DQE suggests that the CTD conductivity offsets should be applied to CTD conductivity in more station groups taking into account the Ds trend as shown in fig. 4. DQE also suggests additional calibration for decreasing the pressure dependency of Ds will improve the quality of CTD salinity.

2.2 Oxygen calibration

Standard deviation of Dox, Dox = CTD oxygen in dot sea file - bottle oxygen, is 4.49 µmol/kg for all depths and the standard deviation of Dox is 0.89 µmol/kg for deeper than 200 dbar. These confirms the good oxygen calibration work. DQE observed no significant station dependency of Dox. DQE observes "weak pressure dependency" of Dox in fig. 5. Although the range of dependency is ca. 1 µmol/kg, if PI of CTDO could correct this tendency, the quality of CTD oxygen data will be further improved.

The following are some specific problems that should be looked at:

Stn. 70 at 4262-4848 dbar and 4150-4172 dbar. CTD salinity looks shifted 0.002 higher. Suggest flg. "3"

Stn. 138 at 3126 dbar and 3128 dbar; CTD oxygen spikes are observed. Suggest flg. "3"

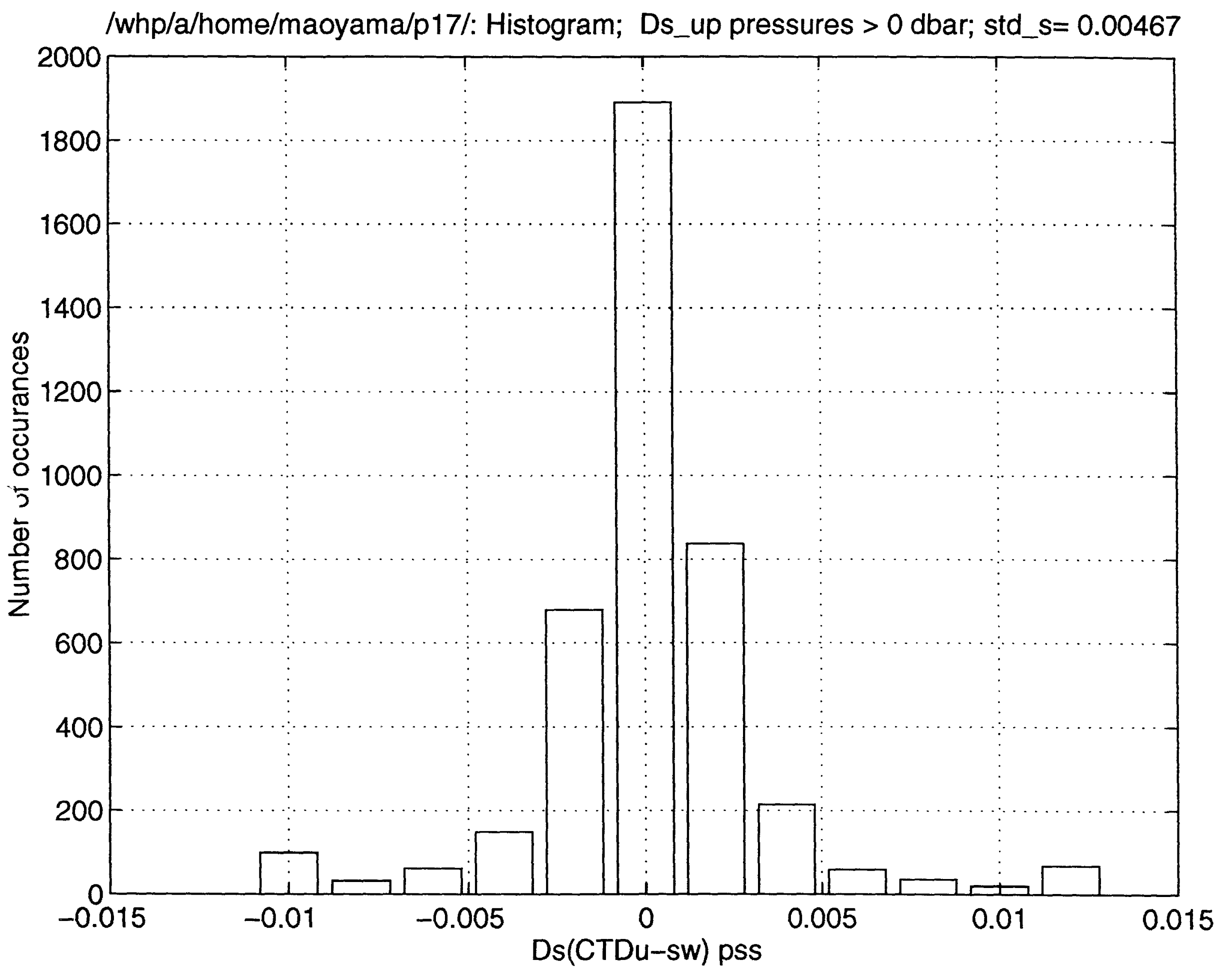

Figure 1

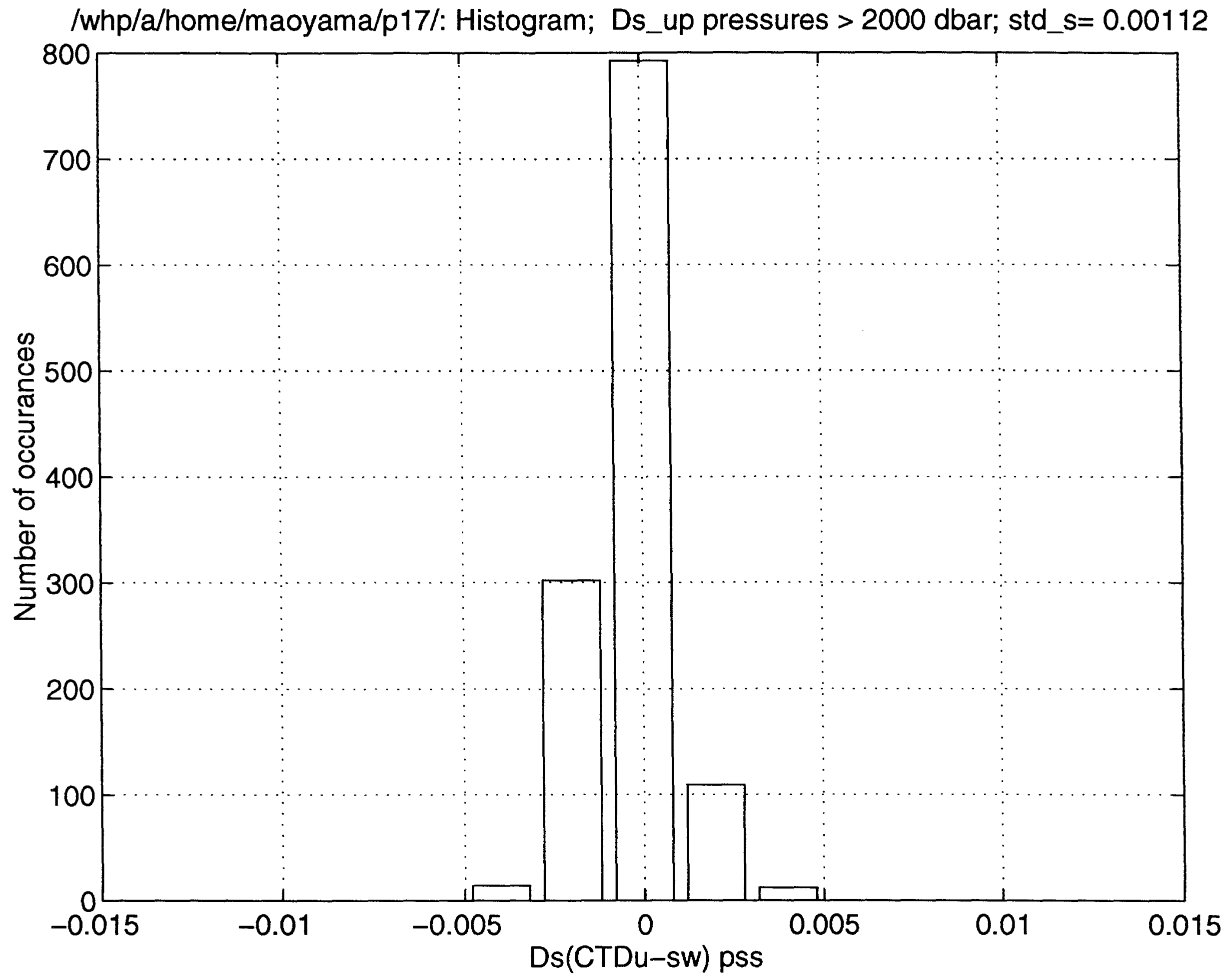
/whp/a/home/maoyama/p17/: Histogram; Ds_up pressures > 2000 dbar; std_s= 0.00112
800
700
600
500
400
300
200
100
0
Number of occurances
−0.015
−0.01
−0.005
0
0.005
0.01
0.015
Ds(CTDu−sw) pss

Figure 2

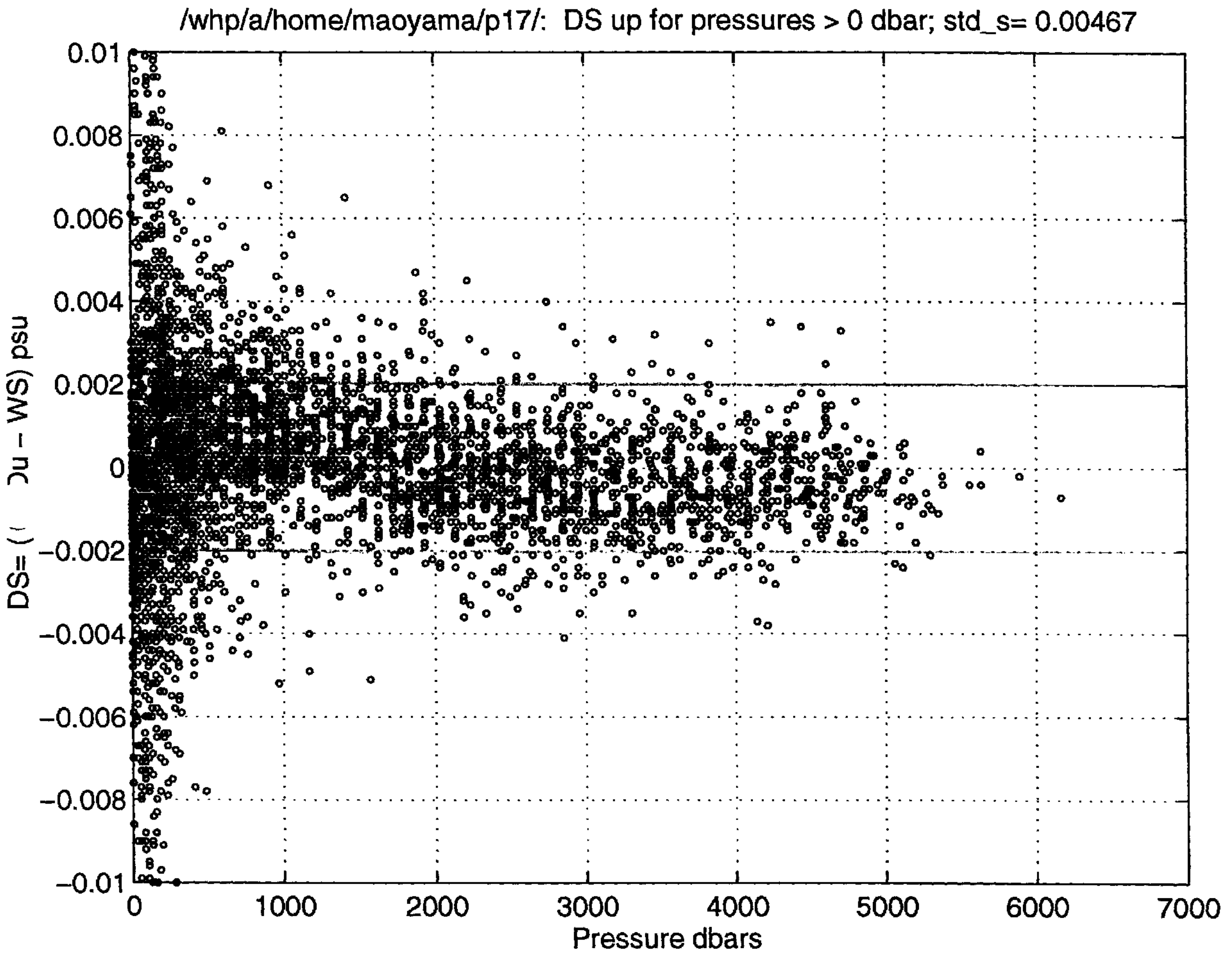
/whp/a/home/maoyama/p17/: DS up for pressures > 0 dbar; std_s= 0.00467
0.01
0.008
0.006
0.004
0.002
0
−0.002
−0.004
−0.006
−0.008
−0.01
0
1000
2000
3000
4000
5000
6000
7000
Pressure dbars
u – WS) psu

Figure 3

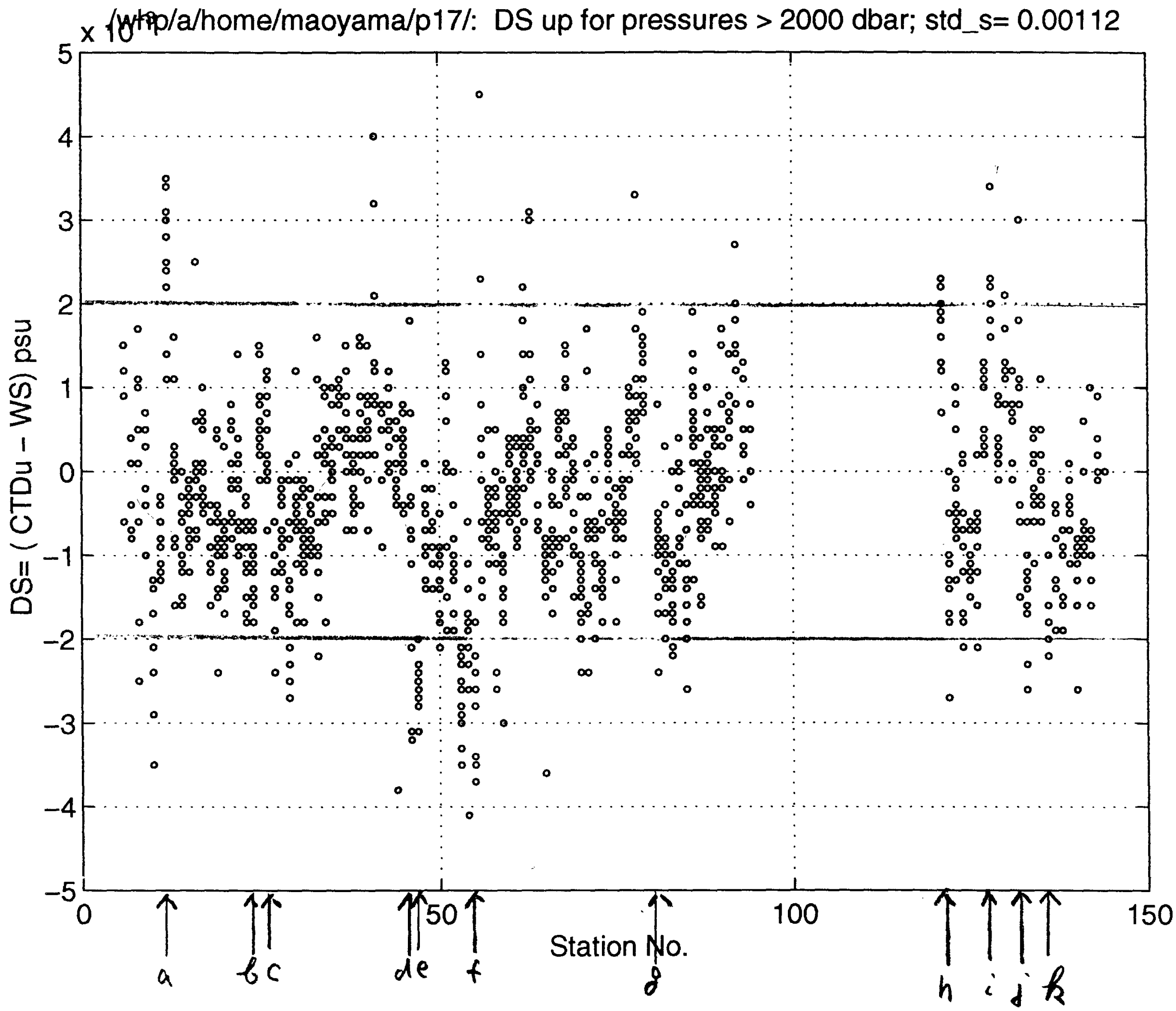
/whp/a/home/maoyama/p17/: DS up for pressures > 2000 dbar; std_s= 0.00112
x 10⁻³
DS= (CTDu – WS) psu
Station No.
5
4
3
2
1
0
−1
−2
−3
−4
−5
0
50
100
150
a
b c
d e
f
g
h
i
j
k

Figure 4

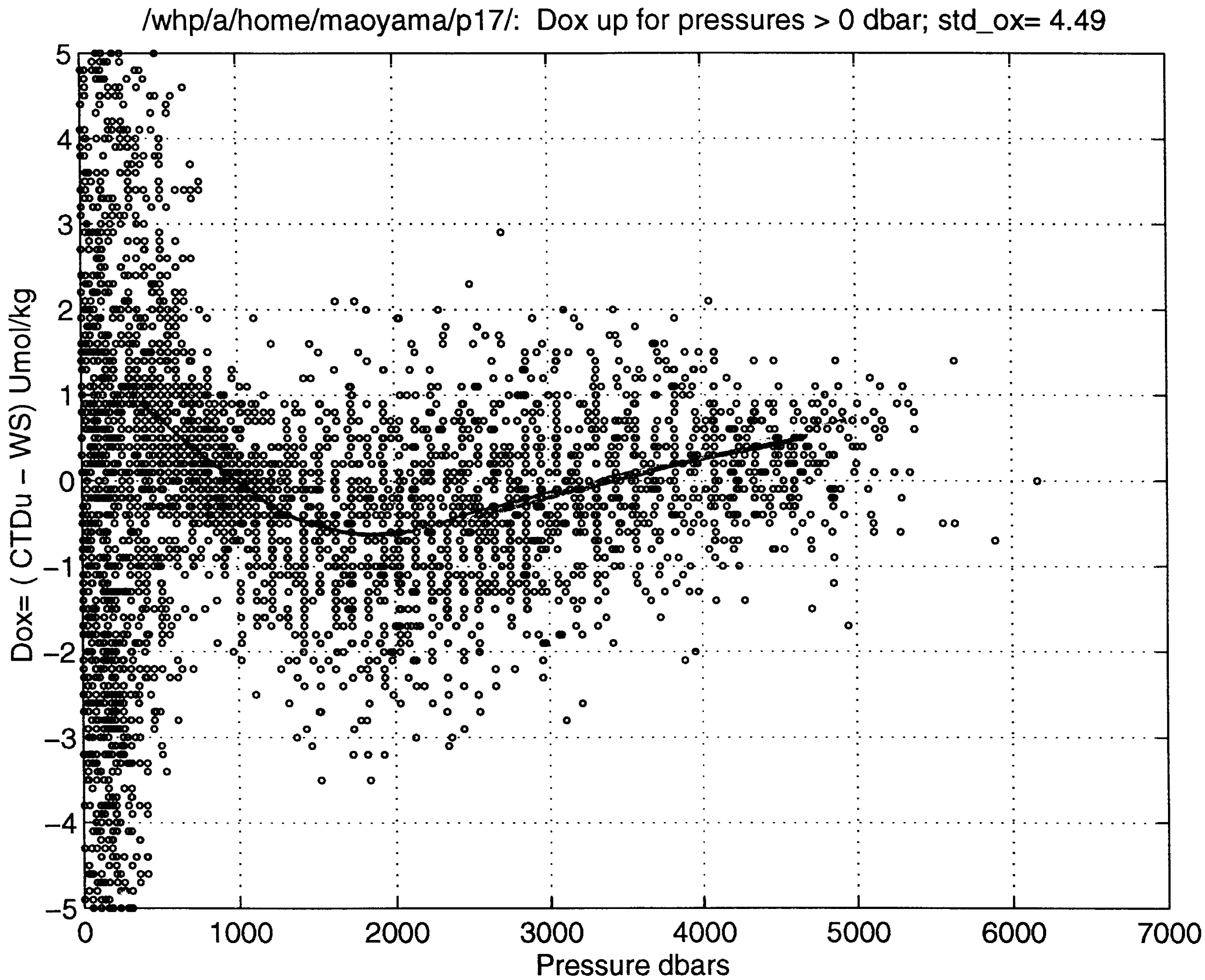

Figure 5

Comments on DQ evaluation of WOCE P17N Hydrographic data (EXPOCODE:325021/1).

Michio AOYAMA 10 April 1996

The data quality of the hydrographic data of the WOCE P17N cruise (EXPOCODE: 325021/1) are examined. The data files for this DQE work was P17N.sum and P17N.mka (this P17N.mka file is created for DQE, then it has a new column of quality 2 word) provided by WHPO.

General;

The station spacing was less than 30 nautical miles and the sampling layer spacing was kept ca. 250 dbar in the deeper layers during this P17N cruise. The ctd lowering were made to within 2 -19 meters to the sea bottom. Since the data originators have done a pretty reliable work in evaluating their data, hydrographic data flagged "2-good" has a pretty good quality. This high density and high quality data will improve our knowledge on the eastern North Pacific following the update of Pacific Ocean deep water data set.

DQE used the data flagged "2" by data originator for this DQE work.

DQE examined 6 profiles, 6 property vs. theta plots, and 2 property vs. property plots as listed below;

salinity, oxygen, silicate, nitrate,nitrite and phosphate profiles
salinity, oxygen, silicate, nitrate,nitrite and phosphate vs. theta plot
nitrate vs. phosphate plot
salinity vs. silicate plot

Salinity;
Bottle salinity profile looks good. Salinity vs. oxygen and theta vs. salinity plots also looks reasonable. DQE thinks that the flags of the bottle salinity data are reliable.

Oxygen;
Bottle oxygen profile looks good. Salinity vs. oxygen and theta vs. oxygen plots also looks reasonable. DQE thinks that the flags of the bottle oxygen data are reliable.

Nutrients;
Since nutrient PI has done a pretty reliable work in evaluating their data, the profiles of silicate, nitrate, nitrite and phosphate looks pretty well. Nitrate vs. phosphate plot and silicate vs. salinity plot also look pretty reasonable. (The data originator was concerned in the comparison with historical silica data in the cruise report. DQE also observes a larger difference between P17N silica and P1 silica data at the crossing. However, a verification of overall traceability among the WOCE cruises and historical data might depend a further work in the near future.)

The following are some specific problems that should be looked at:

STNNBR XX/ CASTNO X/ SAMPNO XX at XXXX dbar:

9/1/36 at 3646 dbar: Silicate concentration looks higher. Suggest flag "3".
44/1/36 at 4207 dbar: Bottle salinity looks higher. Suggest flag "3".
56/1/24 at 1926 dbar: Bottle salinity looks lower. Suggest flag "3".
56/1/27 at 2220 dbar: Bottle salinity looks lower. Suggest flag "3".
78/2/36 at 4703 dbar: Bottle salinity looks lower. Suggest flag "3".

Appendix A

WOCE93-P17N: CTD Temperature and Conductivity Corrections Summary

Sta/ Cast	PRT Response Time (secs)	Temperature Coefficients corT = t2*T^2 + t1*T + t0 t2	t1	t0	Conductivity Coefficients corC = c1*C + c0 c1	c0
001/03	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00907
002/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00912
003/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00917
004/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00922
005/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00927
006/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00932
007/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00857
008/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00862
009/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00867
010/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00952
011/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00957
012/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00962
013/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00967
014/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00972
015/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00976
016/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00981
017/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00986
018/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00991
019/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00996
020/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01001
021/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01006
022/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01011
023/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01016
024/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01021
025/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01026
026/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01031
027/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01036
028/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01041
029/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01046
030/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01051
031/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01055
032/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01060
033/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01065
034/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01070
035/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01075
036/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01080
037/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01085
038/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01090

Sta/ Cast	PRT Response Time (secs)	Temperature Coefficients $corT = t2*T^2 + t1*T + t0$			Conductivity Coefficients $corC = c1*C + c0$	
		t2	t1	t0	c1	c0
039/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01095
040/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01100
041/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01105
042/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01110
043/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01115
044/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01120
045/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01125
046/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00927
047/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01135
048/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01139
049/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01144
050/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01149
051/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01154
052/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01159
053/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01136
054/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01169
055/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01174
056/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01566
057/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
058/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
059/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
060/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
061/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
062/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
063/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
064/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
065/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
066/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
067/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00894
068/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00525
069/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00546
070/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00825
071/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00588
072/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00608
073/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00629
074/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00650
075/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00671
076/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.2312se-04	0.00692
077/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00712
078/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00733
079/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00754
080/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00775

Sta/ Cast	PRT Response Time (secs)	Temperature Coefficients $corT = t2*T^2 + t1*T + t0$			Conductivity Coefficients $corC = c1*C + c0$	
		t2	t1	t0	c1	c0
081/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00796
082/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00816
083/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00837
084/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00858
085/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00879
086/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00900
087/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00920
087/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00920
088/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00941
089/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00962
090/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.00983
091/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01004
092/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01024
093/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01241
094/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01066
095/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01087
096/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01107
097/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01128
098/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
099/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
100/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
101/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
102/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
103/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
104/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
105/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
106/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
107/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
108/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
109/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
110/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
111/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
112/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
113/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
114/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
115/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
116/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
117/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
118/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
119/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
120/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
121/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192

Sta/ Cast	PRT Response Time (secs)	Temperature Coefficients $corT = t2*T^2 + t1*T + t0$ t2	t1	t0	Conductivity Coefficients $corC = c1*C + c0$ c1	c0
122/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
123/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
124/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01317
125/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01272
126/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
127/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
128/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
129/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
130/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
131/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
132/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
133/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
134/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
135/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
136/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
137/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
138/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
139/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
140/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
141/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
142/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
143/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
144/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
145/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
146/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
147/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
148/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
149/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
150/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
151/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
152/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
153/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
154/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
155/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
156/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
157/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
158/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
159/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
160/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
161/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
162/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
163/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192

Sta/ Cast	PRT Response Time (secs)	Temperature Coefficients $corT = t2*T^2 + t1*T + t0$			Conductivity Coefficients $corC = c1*C + c0$	
		t2	t1	t0	c1	c0
164/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
165/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
166/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
167/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
168/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
169/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
170/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
171/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
172/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
173/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
174/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
175/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
176/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
177/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
178/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
179/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
180/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
181/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
182/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
183/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
184/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
185/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
186/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
187/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
188/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
189/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01192
190/02	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01047
191/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01107
192/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01167
193/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01227
194/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01287
195/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01348
196/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01408
197/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01468
198/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01688
199/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01588
200/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01649
201/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01709
202/01	.30	2.18412e-05	-8.71039e-04	-1.48286	-5.23123e-04	0.01644

Appendix B

Summary of WOCE93-P17N CTD Oxygen Time Constants

Temperature Fast(tauTF)	Temperature Slow(tauTS)	Press. (tauP)	O2 Grad. (tauOG)
30.0	400.0	20.0	16.0

WOCE93-P17N CTD Oxygen: O2 Conversion Equation Coefficients
(refer to Equation 1.6.0)

Sta/ Cast	Slope (c1)	Offset (c2)	Pcoeff (c3)	TFcoeff (c4)	TScoeff (c5)	OGcoeff (c6)
001/03	8.08249e-04	-6.40076e-02	2.14888e-03	2.58743e-02	-1.55938e-02	2.05659e-05
002/01	1.07127e-03	-5.68647e-05	3.11544e-04	1.60808e-02	-3.80496e-02	9.39401e-05
003/01	1.67981e-03	-1.28845e-02	2.19669e-04	1.00291e-02	-6.50135e-02	1.05950e-05
004/01	1.15206e-03	-1.73482e-03	1.84306e-04	-4.47063e-02	1.38952e-02	6.82363e-05
005/01	1.60405e-03	-4.74993e-03	1.08628e-04	-3.28119e-02	-2.57445e-02	7.32340e-05
006/01	1.70132e-03	-5.62372e-03	8.97631e-05	2.59637e-02	-7.50146e-02	2.60283e-03
007/01	1.89991e-03	-7.96628e-03	7.98685e-05	-8.38819e-02	-9.03464e-03	2.02129e-04
008/01	1.56450e-03	-1.00155e-02	1.33926e-04	3.15094e-03	-5.53780e-02	1.05236e-04
009/01	1.52302e-03	-6.59903e-03	1.37411e-04	-4.33830e-03	-4.46238e-02	4.45869e-05
010/02	1.65349e-03	-1.33980e-02	1.26108e-04	-1.79467e-02	-4.33929e-02	6.91769e-06
011/01	1.63332e-03	-1.14215e-02	1.22893e-04	1.65771e-02	-6.50816e-02	-1.74424e-05
012/01	1.55696e-03	-9.20419e-03	1.34399e-04	1.34453e-02	-6.14498e-02	-2.18871e-03
013/01	1.55009e-03	-8.96027e-03	1.34753e-04	3.43486e-03	-4.89174e-02	-2.07161e-05
014/01	1.56340e-03	-1.91777e-03	1.26549e-04	-2.76802e-03	-3.99920e-02	-3.01478e-05
015/01	1.39836e-03	4.48094e-03	1.45196e-04	6.58001e-03	-4.21878e-02	-1.00579e-05
016/01	1.43503e-03	1.72736e-03	1.42737e-04	2.03293e-02	-5.84193e-02	-2.72655e-05
017/01	1.44359e-03	-2.52103e-04	1.44564e-04	-4.15755e-03	-3.67312e-02	-1.37264e-05
018/01	1.55175e-03	1.19302e-05	1.28592e-04	1.02470e-02	-5.25375e-02	-1.56899e-05
019/01	1.39516e-03	2.96698e-03	1.46016e-04	8.24101e-03	-4.28389e-02	-1.75933e-05
020/01	1.41227e-03	1.28869e-03	1.45409e-04	1.78737e-02	-5.36906e-02	-8.34299e-06
021/01	1.45612e-03	-4.30351e-04	1.41819e-04	-9.08392e-04	-3.85096e-02	-4.98133e-06
022/01	1.41528e-03	2.30624e-03	1.43606e-04	9.15856e-03	-4.33953e-02	1.20347e-05
023/01	1.42724e-03	3.01431e-03	1.42925e-04	5.99364e-03	-4.12835e-02	3.31005e-05
024/01	1.62697e-03	2.54566e-03	1.17444e-04	-1.93279e-03	-4.14709e-02	-1.20491e-05
025/01	1.40066e-03	9.76925e-04	1.47337e-04	1.21487e-02	-4.65371e-02	-7.68688e-06
026/01	1.48965e-03	3.52237e-03	1.33053e-04	9.05780e-03	-4.71598e-02	2.69666e-06
027/01	1.46932e-03	1.72108e-03	1.36755e-04	5.39400e-03	-4.38037e-02	2.36329e-05
028/02	1.47725e-03	3.33692e-04	1.38579e-04	-4.36826e-04	-3.95995e-02	6.92293e-05
029/01	1.48691e-03	5.69853e-04	1.37699e-04	2.18083e-03	-4.11417e-02	3.77819e-04
030/01	1.50189e-03	-1.99759e-03	1.36658e-04	-4.34406e-03	-3.54488e-02	3.36092e-06
031/01	1.44227e-03	-6.96868e-04	1.42609e-04	1.97990e-02	-5.46878e-02	-2.00396e-05
032/01	1.52533e-03	2.55718e-04	1.31322e-04	2.68116e-02	-6.38338e-02	2.90037e-05
033/01	1.46261e-03	2.80720e-03	1.37339e-04	1.48312e-02	-5.16318e-02	3.86006e-05
034/01	1.42664e-03	9.80097e-04	1.43465e-04	-1.17286e-03	-3.69689e-02	2.53383e-06

Sta/ Cast	Slope (c1)	Offset (c2)	Pcoeff (c3)	TFcoeff (c4)	TScoeff (c5)	OGcoeff (c6)
035/01	1.44567e-03	1.16777e-03	1.42394e-04	2.17071e-02	-5.98951e-02	-2.24789e-05
036/01	1.58496e-03	4.14128e-03	1.21112e-04	6.11612e-02	-1.06795e-01	-2.17558e-06
037/01	1.52797e-03	-2.00049e-03	1.35571e-04	-8.19798e-03	-3.97432e-02	5.60934e-05
038/01	1.47803e-03	1.65652e-04	1.36726e-04	6.31856e-03	-4.64918e-02	-5.93265e-06
039/02	1.47945e-03	7.94537e-06	1.38166e-04	2.17784e-03	-4.34670e-02	7.81198e-06
040/01	1.47109e-03	-1.79635e-03	1.41663e-04	7.48094e-03	-4.86065e-02	-1.40771e-05
041/01	1.47071e-03	-1.45422e-03	1.43499e-04	2.54808e-02	-6.68503e-02	-3.81862e-05
042/01	1.39117e-03	-1.58515e-04	1.55600e-04	2.04201e-02	-5.14260e-02	-1.25502e-06
043/01	1.55805e-03	6.72145e-03	1.14973e-04	1.19677e-02	-5.42077e-02	4.10889e-06
044/01	1.38342e-03	-6.71452e-04	1.54513e-04	1.08952e-02	-4.56573e-02	-1.12276e-05
045/01	1.34574e-03	-6.23142e-04	1.60751e-04	-1.38979e-02	-1.93505e-02	-9.63846e-06
046/01	1.40539e-03	9.28910e-04	1.48065e-04	2.19372e-02	-5.37551e-02	-4.53752e-05
047/01	1.42687e-03	1.25969e-03	1.46974e-04	1.18470e-02	-4.64536e-02	2.65292e-05
048/02	1.38312e-03	1.02774e-03	1.54533e-04	1.88749e-02	-5.45223e-02	-1.35825e-05
049/01	1.46340e-03	5.16205e-03	1.36857e-04	-1.14775e-03	-4.01270e-02	2.47830e-07
050/01	1.43880e-03	6.07636e-03	1.39465e-04	1.63194e-02	-5.58422e-02	-3.81429e-05
051/01	1.47830e-03	1.01043e-03	1.40580e-04	9.40733e-03	-5.44683e-02	-3.12150e-05
052/01	1.43307e-03	1.00991e-03	1.44459e-04	1.35293e-02	-5.38582e-02	-3.46634e-05
053/01	1.52507e-03	-9.53142e-04	1.32391e-04	2.46826e-02	-6.91162e-02	-4.41765e-05
054/01	1.45393e-03	6.72339e-03	1.36978e-04	3.72207e-02	-7.62022e-02	-3.59719e-05
055/01	1.47689e-03	3.10573e-03	1.35091e-04	1.66772e-02	-5.88435e-02	-5.21160e-06
056/01	1.48631e-03	2.22681e-03	1.34947e-04	3.35874e-02	-7.62168e-02	-3.47811e-05
057/02	1.38435e-03	7.84251e-03	1.44911e-04	2.49900e-02	-6.12988e-02	-1.16616e-05
058/02	1.62875e-03	-8.72551e-04	1.20427e-04	2.38463e-02	-8.06760e-02	-6.65128e-05
059/01	1.46640e-03	8.48804e-04	1.38953e-04	3.85820e-02	-7.88613e-02	-3.04070e-05
060/01	1.54975e-03	3.83312e-03	1.26589e-04	3.54479e-02	-7.90420e-02	-1.67068e-05
061/01	1.55314e-03	2.94371e-03	1.26207e-04	3.18457e-02	-7.65876e-02	-2.58869e-05
062/02	1.39049e-03	3.57359e-03	1.49993e-04	-1.28702e-02	-3.05422e-02	1.39450e-05
063/01	1.64386e-03	2.55320e-03	1.16372e-04	4.21452e-02	-9.37279e-02	-5.57016e-05
064/01	1.53404e-03	3.61145e-03	1.29246e-04	-1.52727e-03	-4.57307e-02	-1.64014e-05
065/01	1.41155e-03	1.32094e-03	1.45988e-04	2.58938e-02	-6.22222e-02	-6.12525e-06
066/01	1.48561e-03	4.66548e-04	1.39693e-04	-6.04798e-03	-4.40219e-02	8.03343e-05
067/01	1.58518e-03	1.46296e-03	1.24625e-04	2.91277e-02	-8.07744e-02	-2.13405e-05
068/02	1.39818e-03	1.87451e-03	1.48898e-04	-8.31480e-03	-3.48424e-02	-1.82338e-06
069/01	1.68179e-03	9.81732e-05	1.17460e-04	3.12916e-02	-9.57879e-02	-4.29382e-06
070/01	1.71991e-03	1.27787e-02	1.01335e-04	-4.79902e-03	-5.80875e-02	1.44197e-05
071/01	1.40506e-03	2.19643e-03	1.48742e-04	-6.33120e-04	-4.57440e-02	-1.58956e-05
072/01	1.50390e-03	-3.31856e-04	1.37915e-04	3.05159e-03	-5.47834e-02	5.71624e-07
073/01	1.68135e-03	9.30561e-03	1.52799e-04	-3.71046e-01	1.79616e-01	8.84298e-04
074/01	1.49505e-03	1.58314e-03	1.40436e-04	-3.37244e-03	-5.35345e-02	-4.05708e-06
075/01	1.48214e-03	7.06264e-04	1.43229e-04	1.80966e-03	-6.22202e-02	-4.59910e-05
076/01	1.43118e-03	5.10642e-03	1.44017e-04	-8.25999e-03	-4.09775e-02	-4.34529e-07
077/01	1.38522e-03	6.05709e-03	1.46795e-04	-3.72838e-03	-3.76986e-02	-3.96067e-05
078/02	1.68323e-03	-4.44644e-03	1.23583e-04	-1.31166e-03	-7.82426e-02	-1.50763e-05

Sta/ Cast	Slope (c1)	Offset (c2)	Pcoeff (c3)	TFcoeff (c4)	TScoeff (c5)	OGcoeff (c6)
079/01	1.49198e-03	4.88965e-03	1.35594e-04	7.04801e-02	-1.23021e-01	-3.53750e-05
080/01	1.61879e-03	-3.45542e-04	1.27344e-04	2.82449e-02	-9.98537e-02	-2.79902e-05
081/01	1.41651e-03	6.40519e-03	1.42678e-04	7.71225e-02	-1.19913e-01	-2.88168e-05
082/01	1.57927e-03	1.00646e-02	1.22418e-04	6.46037e-02	-1.27086e-01	1.10433e-05
083/01	1.53671e-03	4.04597e-03	1.36531e-04	4.57579e-02	-1.15757e-01	3.87946e-05
084/01	1.56659e-03	1.32654e-03	1.31960e-04	-6.64047e-03	-5.75114e-02	-1.01171e-05
085/01	1.62253e-03	4.72606e-04	1.23617e-04	5.00856e-02	-1.14334e-01	-7.22586e-06
086/02	1.54570e-03	-4.54788e-03	1.37703e-04	3.83908e-03	-6.92528e-02	2.30986e-05
087/01	1.49623e-03	7.45157e-03	1.33338e-04	2.91205e-02	-8.04186e-02	-1.65387e-06
087/02	1.49623e-03	7.45157e-03	1.33338e-04	2.91205e-02	-8.04186e-02	-1.65387e-06
088/01	1.51326e-03	-4.62779e-03	1.39521e-04	1.91182e-02	-7.38301e-02	7.49944e-05
089/01	1.51833e-03	-2.23605e-03	1.36236e-04	-9.55286e-03	-4.59941e-02	1.24566e-03
090/01	1.33851e-03	7.28159e-03	1.50475e-04	2.42343e-02	-5.60314e-02	6.23109e-05
091/01	1.39995e-03	6.62175e-03	1.44223e-04	1.49109e-02	-5.15956e-02	3.05412e-05
092/01	1.17994e-03	5.81480e-03	1.81230e-04	2.11278e-02	-3.41154e-02	1.00067e-04
093/01	1.20235e-03	3.23575e-03	1.94670e-04	9.08327e-02	-1.05979e-01	2.40186e-06
094/01	7.26702e-04	5.79481e-03	3.33202e-04	1.60709e-02	3.25142e-02	2.24224e-05
095/01	9.72866e-04	2.53468e-03	2.78680e-04	3.12486e-02	-2.28419e-02	-9.47967e-06
096/01	1.12660e-03	1.52622e-03	2.36632e-04	-5.21582e-03	-8.70255e-03	-6.46160e-06
097/01	9.11864e-04	-9.83649e-03	8.29806e-04	1.16155e-02	5.17479e-03	-1.63913e-06
098/01	7.37485e-04	1.54821e-03	7.02487e-04	1.08206e-02	3.23053e-02	6.15701e-05
099/01	4.62936e-04	-4.64534e-02	2.20503e-03	3.48825e-02	7.31513e-02	-2.78937e-05
121/01	1.52452e-03	4.37773e-04	1.32762e-04	6.75907e-02	-1.25932e-01	-3.22286e-05
122/01	1.49661e-03	4.20465e-03	1.29996e-04	8.37335e-02	-1.25576e-01	-5.20607e-05
123/01	1.53711e-03	-1.82531e-03	1.33446e-04	2.28559e-03	-5.56371e-02	4.47570e-06
124/01	1.47129e-03	-4.94488e-03	1.44073e-04	2.79503e-02	-7.60030e-02	-2.14490e-05
125/01	1.49764e-03	5.84991e-03	1.30787e-04	1.58664e-02	-6.10576e-02	1.04223e-04
126/01	1.55294e-03	-9.92309e-03	1.40080e-04	4.93630e-03	-7.35055e-02	1.51939e-05
127/01	1.46482e-03	1.57159e-03	1.37795e-04	4.22539e-02	-8.60623e-02	-5.37647e-05
128/01	1.35260e-03	-7.07638e-03	1.74427e-04	1.22078e-02	-6.02338e-02	1.00445e-05
129/01	1.62571e-03	-6.12452e-03	1.22267e-04	5.24868e-03	-6.87738e-02	-1.82067e-05
130/01	1.42837e-03	2.02694e-03	1.47077e-04	-1.02766e-03	-4.62502e-02	3.81534e-05
131/01	1.31304e-03	-9.40718e-04	1.69007e-04	1.08360e-02	-4.56653e-02	1.53044e-05
132/02	1.49242e-03	-1.08839e-02	1.43320e-04	4.01473e-02	-8.71190e-02	-4.01181e-05
133/01	1.41655e-03	-2.55611e-03	1.50538e-04	3.12334e-02	-7.21314e-02	-2.74546e-05
134/01	1.60644e-03	-4.70651e-03	1.22375e-04	8.96500e-03	-6.48104e-02	-5.96979e-06
135/01	1.50888e-03	-6.25451e-03	1.38627e-04	7.77918e-03	-5.72083e-02	-1.68687e-05
136/01	1.20595e-03	5.88210e-03	1.79267e-04	-1.20234e-02	-1.65762e-02	4.31541e-05
137/01	1.23144e-03	4.18087e-03	1.76495e-04	1.02956e-02	-3.51235e-02	-2.75787e-05
138/01	1.60733e-03	-2.24807e-03	1.21539e-04	-6.92771e-03	-5.66909e-02	2.16705e-05
139/01	1.44330e-03	-2.29646e-05	1.44519e-04	1.79498e-02	-6.01069e-02	-1.81917e-05
140/01	1.31737e-03	-8.02100e-04	1.67207e-04	8.79017e-03	-4.18855e-02	-2.71284e-05
141/02	1.38742e-03	-2.03718e-03	1.54653e-04	1.97025e-02	-5.80731e-02	-3.75762e-06

Sta/ Cast	Slope (c1)	Offset (c2)	Pcoeff (c3)	TFcoeff (c4)	TScoeff (c5)	OGcoeff (c6)
142/01	1.35897e-03	-6.68678e-03	1.65889e-04	1.92085e-03	-4.30092e-02	1.37756e-05
143/01	1.26289e-03	2.34998e-03	1.87015e-04	-2.58844e-02	-8.46360e-03	1.02403e-04
144/01	1.01973e-03	4.58694e-03	2.69356e-04	-2.68893e-02	8.47161e-03	7.49903e-05
145/01	1.40856e-03	-1.12580e-03	1.82455e-04	-4.81375e-03	-3.91051e-02	2.67259e-05
146/01	1.00011e-03	-7.26369e-03	5.31017e-04	-2.28122e-02	5.30475e-03	5.44317e-05
147/01	2.61426e-03	1.12753e-01	-1.31664e-03	5.24554e-03	-8.96052e-02	-1.87331e-05
148/01	4.33342e-03	4.23867e-01	-2.16556e-03	5.93505e-03	-1.32612e-01	9.07801e-06
188/01	4.68362e-03	4.32891e-01	-3.53223e-03	-1.08147e-01	-6.34708e-02	1.86758e-04
189/01	5.14719e-04	-1.36832e-02	1.28591e-03	-1.48095e-02	5.00234e-02	2.63096e-05
190/02	1.42946e-03	1.70582e-03	1.05035e-04	2.81890e-04	-2.46893e-02	-2.18368e-05
191/01	1.28114e-03	-1.60529e-02	2.05266e-04	-1.33111e-03	-3.24322e-02	3.81289e-05
192/01	1.49733e-03	-2.39870e-02	1.42402e-04	8.48266e-03	-5.05112e-02	6.67075e-05
193/01	1.24753e-03	-1.69402e-02	1.92302e-04	-4.51785e-03	-2.47189e-02	-3.70810e-06
194/01	1.55748e-03	-1.18999e-02	-4.24017e-05	-2.07235e-02	-3.11347e-02	9.74563e-05
195/01						
196/01	1.10358e-03	-8.77145e-03	2.52811e-04	-3.01090e-03	-2.06438e-02	-1.22407e-05
197/01	1.02058e-03	-7.85941e-03	2.75341e-04	5.35448e-03	-1.36687e-02	-5.53547e-05
198/01	1.05803e-03	-3.65090e-03	2.55797e-04	-1.49696e-02	-3.54866e-03	3.68105e-06
199/01	1.07034e-03	-4.13163e-03	2.35075e-04	-7.02755e-03	-8.24126e-03	-1.71616e-05
200/01	1.27718e-03	-5.94235e-03	1.76546e-04	2.62068e-03	-3.28459e-02	-1.05277e-05
201/01	1.13142e-03	-1.62351e-02	2.51330e-04	-1.02596e-02	-2.32896e-02	-1.10488e-05
202/01	1.25020e-03	-1.22677e-02	1.97310e-04	-4.45355e-03	-2.37119e-02	-3.56398e-05

Appendix C

Quality Comments

Remarks for deleted samples, missing samples, and WOCE codes other than 2 from WOCE P17N. Investigation of data may include comparison of bottle salinity and oxygen data with CTD data, review of data plots of the station profile and adjoining stations, and rereading of charts (i.e., nutrients). Comments from the Sample Logs and the results of ODF's investigations are included in this report. Units stated in these comments are milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, and Phosphate, unless otherwise noted. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 001

332 Salinity drawn but not run. Started with bath temp 18 C and air went up to 19°C. Note on Salinometer Log "Air temp change, could not read, quit 5" (5 is salt bottle nbr for sample 332. Remaining 4 samples run later after bath temp stabilized at 21°C. Footnote salinity lost.

Station 002

125 Delta-S .017 low at 103db. 4 Autosal runs for agreement. Spike on salinity up trace this level. Footnote CTD salinity bad.

136 Sample log: "Air Leak" Delta-S .000 at 542db. Other water samples also ok.

Station 003

117 Delta-S .03 low at 28db. Calc ok. High gradient. Wrong suppression setting, used 1.90159 vs 1.80159. CTD salinity also a little noisy, footnote CTD salinity bad. Bottle salinity agrees with Station 002, bottle salinity is acceptable.

118 SiO3 appears ~3.0 high, same value as level below. Calc & peak ok. Other parameters have normal gradient. Similar feature next station. Footnote SiO3 questionable, let PI decide.

136 Sample log: "Air leak again. Changed lanyard last time." Adjusted air vent o-ring after this station, ok. Delta-S .0007 at 1014db. Other water samples also ok.

Station 004

124 Original salinity data sheet(PC printout) has bottle sampler numbers confused starting after 23. Salt bottle 24 drawn from bottle 24 per Sample Log but no Autosal run shown for salt bottle 24. Assume Sample log order correct & bottle 24 salt not run. Footnote salinity lost.

128 Delta-S .005 low at 509db. Calc ok. Other water samples ok. No notes on Sample Log. Salinity as well as other data are acceptable.

136 Delta-S .055 low at 1419db. Calc ok. Sil also low with good peak and calc. Other water samples look ok but could be leaking bottle and O2, NO3 & PO4 accidentally give reasonable values. No notes on Sample Log. Footnote bottle leaking and samples bad. ODF recommends deletion of all water samples.

Station 005
111-122 Sample log: "On O2 Nis22 found MnCl2 on 2ml" O2s from surface to 356db (111-122) look ok compared to CTDO and adjacent stations. Oxygen is acceptable.

Station 006
108 Delta-S .03 low at 30db. Calc ok assuming read at wrong suppression setting (1.81621 entered, assume should be 1.91621). Two bottles tripped at 30db and all water samples indicate bottle 8 closed higher than bottle 9. High gradient so probably ok. Salinity is acceptable.

Station 007
102 Delta-S .03 high at 1db. Autosal run ok but sample nbr and salt bottle nbr both recorded as 1 vs. 2. Sample log has salt bottle nbr 2. High gradient & down not same as up. Footnote salinity questionable.
127 Delta-S .003 high at 1623db. Calc & Autosal run ok. Normal gradient. No notes. Other water samples ok. CTD salinity also a little noisy, footnote CTD salinity bad. Salinity as well as other data are acceptable.

Station 008
102 Delta-S .015 high at 30db. Calc & Autosal run ok. CTD T & S spikes on up trace. Other water samples ok. Footnote CTD salinity bad.
103 Sample log: "Did not close - bottom lanyard hungup." No water samples.
131 Delta-S .003 high at 2422db. Calc & Autosal run ok. Normal gradient. Other water samples ok. No notes. Salinity as well as other data are acceptable.
132 Delta-S .004 high at 2628db. Calc & Autosal run ok. Normal gradient. Other water samples ok. No notes. Salinity as well as other data are acceptable.

Station 009
109 Delta-S .014 high at 207db. Calc & Autosal run ok. Normal gradient. No notes. Other water samples ok. Salinity as well as other data are acceptable.
132 Bottle salt drawn but not run. No note on salinity data sheet. Possible Autosal problem and ran out of sample before getting good readings; salinity lost.
133 Delta-S .006 high at 3123db. Calc ok, only 2 tries for agreement. Other water samples ok. No notes. Footnote salinity bad just too far off, other data are acceptable.
136 PO4 .05 high at 3647db. n:p ratio low. Calc ok & peak fair but definitely high. No recorder trace problem between 135 and 136. There was an air bubble that the analyst found and corrected. The problem with this value could be an air bubble that was undetected and uncorrectable. Footnote PO4 questionable.

Station 010
229 Delta-S .002 high at 2336db. Calc & Autosal run ok. Normal gradient. No notes. Other water samples ok. Salinity as well as other data are acceptable.
232 Delta-S .002 high at 2951db. Calc & Autosal run ok. Normal gradient. No notes. Other water samples ok. Salinity as well as other data are acceptable.

Station 011

106 Sample log: "Did not trip" Pylon problem per ConOps. Assigned bottle 6 the surface pressure just for the CTD data.

101-106 Data indicates bottle 5 tripped at level intended for bottle 6 and all remaining bottles above tripped one level lower than intended. No water samples at surface level. Footnote bottle did not trip as scheduled.

103 Delta-S .05 low at 82db. Calc ok. High gradient & inversion. Other water samples ok. Bottle salinity acceptable.

104 Wrong suppression setting, used 1.90410 vs 1.80410. Delta-S .005 high at 108db. Bottle salinity acceptable.

105 Delta-S .02 low at 132db. Wrong suppression setting, used 1.90521 vs 1.80521. High gradient & down trace not same as up. Other water samples ok. Bottle salinity acceptable.

107 Bottle O2 appears 1.0 high at 158db. Calc & titration ok. No notes. Delta-S .005 high and nutrients also ok. Down & up CTDO traces show no O2 inversion this level. Footnote oxygen questionable.

117 Sample log: "Air leak" Delta-S .0015 high at 612db. Other water samples also ok.

135 Delta-S .007 high at 4082db. Calc ok but 4 tries to get agreement. Other water samples ok. Possibly salt crystal contamination when sample bottle opened. ODF recommends deletion of salinity sample. Footnote salinity bad.

Station 012

102 Delta-S .016 high at 31db. Calc & Autosal run ok. High gradient & inversion. Uptrace CTD T & S spike. Footnote CTD salinity bad.

107 Delta-S .13 high at 158db. All water samples indicate deeper water. Possibly bottom end cap closed early. Footnote bottle leaking and samples bad.

134 Delta-S .003 high at 3970db. Calc & Autosal run ok. Same value as bottle 35 salt one level below. Possible dupe draw or run. Other water samples ok. Footnote bottle salinity bad.

Station 013

103 Delta-S .014 low at 53db. Calc & Autosal run ok. Down & up T differ. Small uptrace CTD spike. Footnote CTD salinity bad. Bottle salinity is acceptable.

Station 014

105 Sample log: "Odd temp reading. Closed early?" Delta-S .5 high at 108db. All water samples indicate deeper water. Possibly bottom end cap closed early. Footnote bottle leaking, samples bad. ODF recommends deletion of all water samples.

129 Delta-S .003 high at 2901db. Calc & Autosal run ok. Other water samples ok. Footnote salinity questionable.

Station 015

103 Delta-S .012 high at 58db. Calc & Autosal run ok. High gradient. Down differs from up. Uptrace CTD spike. Footnote CTD salinity bad. Bottle Salinity acceptable.

Station 016

Cast 1 Pylon tripping problems. Note on ConOps for bottle 28 at 2877db:"Reset to 8 for tripping" Note on ConOps for bottle 29 at 3082db:"FF32 ? ! <--31 may have tripped here" No confirmation first 2 tries at 108db level. Data indicates no sample at intended bottle 28 level (2852.6db) and bottles 28 thru 7 tripped one level higher than intended. Data indicates bottles 5 thru 3 tripped two levels higher than intended. No samples from bottles 1, 2, & 6. CTD trip data bottles 1 through 28 reassigned appropriately.

101-102 ConOps note: "Open when rosette came on deck."

106 ConOps note: "Open when rosette came on deck."

134 Delta-S .03 low at 4341db. Calc ok. All water samples indicate leaking bottle. No notes on Sample Log. Footnote bottle leaking and samples bad. ODF recommends deletion of all water samples.

135 Delta-S .003 low at 4600db. Calc & Autosal run ok. Other water samples ok. Bottle salinity acceptable.

Station 017

123 Delta-S .003 low at 1962db. Calc ok, 3 Autosal runs. Other water samples ok. Normal gradient. Salinity as well as other data are acceptable.

126 Delta-S .003 low at 2584db. Calc ok, 3 Autosal runs. Other water samples ok. Normal gradient. Salinity as well as other data are acceptable.

Station 018

124 Sample log:"Lanyard from bottle 25 caught in top end cap bottle 24." Delta-S .013 low at 2031db. Footnote bottle leaking and samples bad. ODF recommends deletion of all water samples.

131 Delta-S .004 high at 3569db. 3 Autosal runs with 2nd & 3rd equal. Same value as bottle 32 salt at level below. Other water samples have normal gradient. Possible dupe draw. Footnote salinity bad. ODF recommends deletion of salinity sample.

134 Sample log:"Lanyard from bottle 35 caught in top end cap bottle 34." Delta-S .008 low at 4341db. Footnote bottle leaking and samples bad. ODF recommends deletion of all water samples.

Station 019

102 Pylon problem reported per Console Operations log. This should have tripped at 25db, but tripped at 58db. Footnote bottle did not trip as scheduled. However, samples are acceptable after reassignment of pressure.

103 Sample log: "Did not close" Pylon problem per ConOps. bottle 2 closed at intended bottle 3 level (58db) and no sample at bottle 2 intended level (25db). Did not report this level since the CTD information was from the same pressure as bottle 2.

109 Delta-S .011 low at 182db. Calc & Autosal run ok. CTD S spike. Footnote CTD salinity bad.

124 Sample log:"Air leak. Lanyard from bottle 25 in top end cap bottle 24. O2 only drawn. Footnote bottle leaking and o2 bad. ODF recommends deletion of water samples.

129 Sample log: "Bottom lanyard hung up on sleeve" No samples.

Station 021

109 Delta-S .021 low at 222db. Calc & Autosal run ok. CTD T spike on up trace. CTD spike on up trace, footnote CTD salinity bad.

121 Delta-S .04 high at 1231db. Other water samples indicate deeper water. Probably bottom end cap closed early. Footnote bottle leaking, samples bad. ODF recommends deletion of all water samples.

130 Delta-S .003 low at 3546db. Calc & Autosal run ok. Same value as bottle 31 at level below. Other water samples ok. Possible dupe draw. Footnote salinity bad.

Station 023

Cast 1 This cast tripped in different order to get bottle freon blanks for bottles normally used near surface. Bottle 13 was first bottle tripped (deepest) and bottle 14 was last bottle tripped (surface). All PO4 appear about .05 low on Stations 23 & 24. Low nutrient sea water of questionable quality used these two stations only. Footnote PO4 bad.

118 Delta-S .015 high at 107db. Calc & Autosal run ok. CTD S spike. Inversion, high gradient. Footnote CTD salinity bad.

121 Delta-S .015 low at 183db. Calc & Autosal run ok. CTD S & T spike. Footnote CTD salinity bad.

125 Delta-S .05 high at 360db. Calc ok & Autosal run ok. Other water samples ok. Value different from 25 on Sta21, last time this salinity bottle used. Normal CTD T & S traces. Possible rinsing problem. Footnote salinity bad.

137 Sample log: "Leaking from bottom end cap after air vent open" Delta-S .000 at 1320db. Other water samples also ok.

Station 024

Cast 1 All PO4 appear about .05 low on Stations 23 & 24. Low nutrient sea water of questionable quality used these two stations only. Footnote PO4 bad.

103 Delta-S .018 low at 60db. Calc & Autosal run ok. Inversion. CTD S spike. Footnote CTD salinity bad.

118 Sample log: "Salt (bottle) 18 has chip" Delta-S .000 at 1015db. Salinity is acceptable.

136 CTD Processor: "Power outage on down cast - CTD O2 "questionable" 4902 db to bottom (quality coding as "3")."

Station 025

108 Delta-S .012 high at 184db. Calc & Autosal run ok. CTD T & S spikes on up trace. Footnote CTD salinity bad.

126 Silicate 1.0 low at 2689db. Calc & peak ok. Other samples including nitrate & phosphate have normal gradient. Footnote SiO3 questionable.

Station 026

119 Delta-S .115 high at 911db. Calc & Autosal run ok. Same value as sample 119 on Sta 24, last time this salt bottle used. Assume drawing error. Footnote salinity bad.

121 Delta-S .033 high at 1316db. Other water samples ok. bottle 22 salt value .034 low so most likely salt samples swapped. Used salt bottle 22 for sample 121. After corrections made, data is acceptable.

122 Delta-S .034 low at 1521db. Oxygen ok. bottle 21 salt value .033 high so most likely salt samples swapped. Nutrient values same as bottle 21, other parameters have normal gradient so assume dupe draw from 21. Nutrients in sample tube for 23 match gradient for bottle 22 level better than bottle 23 level. Used salt bottle 21 for sample 122. Used nutrients from tube 23 for bottle 22. After corrections made, data is acceptable.

123 Nutrients from tube 23 match bottle 22 level. See 122 above. Assume no nutrients drawn from bottle 23.

Station 027

Cast 1 Pylon malfunction problems this station. Bottle levels determined by data values, comparing bottle salts & oxygens with CTD values and all data with adjacent stations. Footnote bottle did not trip as scheduled. Samples are acceptable after pressure assignment corrected.

107 Not tripped. No water samples. Assigned bottle 7 the deepest pressure just for the CTD data. See Cast 1 tripping comment. CTD Processor: "power outage on down cast - CTD O2 "questionable" 5214 db to bottom."

125 Delta-S .014 high at 2444db. Calc & Autosal run ok. O2, NO3 & PO4 samples ok. No notes. Footnote salinity bad.

137 Delta-S .002 low at 4341db. Calc & Autosal run ok. Same value as bottle 32 at level above. Nutrients are also same value as bottle 32 but oxygen has normal gradient. Peaks ok. CTD and adjacent stations have normal gradient this level. Possibly dupe draws from bottle 32 and no salt or nutrients from bottle 37. Same person drew salts and nutrients this station. Footnote salinity bad.

138 Delta-S .09 low at 5113db. All water samples appear to be from about 1900db. Does not fit trip sequence of other bottles. Assume bottle 38 had an independent lanyard hangup or trip problem. Footnote bottle leaking, samples bad. ODF recommends deletion of all water samples.

Station 028

225 Delta-S .02 low at 2750db. Calc & Autosal run ok. Same value as sample 125 on Station 18, which was the last time this salt box was used. Assume drawing error. Footnote salinity bad. ODF recommends deletion of salinity sample.

231 Delta-S .2 low at 4216db. Calc & Autosal run ok. Other water sample also from higher level. Footnote bottle leaking and samples bad. ODF recommends deletion of all water samples.

Station 029

126 Delta-S .007 high at 2697db. Calc & Autosal run ok. Same value as sample 127 below. Other water samples ok. Assume 126 salt drawn from bottle 27. Footnote salinity bad.

130 Delta-S .013 low at 3642db. Calc & Autosal run ok. Same value as sample 130 on Station 26, last time this salt box used. Other water samples ok. Assume drawing error. Footnote salinity bad.

Station 030

104 Delta-S .036 high at 72db. 4 Autosal run to get agreement. High gradient. Down differs from up. CTD S spike. Footnote CTD salinity bad. Salinity is acceptable.

117 Delta-S .006 low at 1068db. Calc & Autosal run ok. Normal gradient. Other water samples look ok. Salinity is acceptable.

121 Delta-S .005 low at 1879db. Calc & Autosal run ok. Normal gradient. Other water samples look ok. Salinity is acceptable.

Station 031

106 Nutrient data sheet: "Sample cup empty" Ok on sample log. Sample tube apparently turned up but not filled.

Station 032

105 Delta-S .012 low at 96db. Calc & Autosal run ok. Small CTD spike. Footnote CTD salinity bad.

112 Sample log: "Spigot collar loose" Delta-S .002 low at 369db. Other water samples also ok.

127 Delta-S .002 high at 2851db. 3 Autosal runs for agreement. Normal gradient. Footnote salinity bad.

Station 033

109 Delta-S .014 low at 233db. Calc & Autosal run ok. Small CTD spike. Footnote CTD salinity bad.

131 Silicate appears 2.0 high at 3923db. Same value as level above. Calc & peak ok. Delta-S .003 low. Calc & Autosal run ok. O2, PO4 & NO3 appear to have normal gradient but all have higher and lower values in water column above so slight leak possible. No notes on sample log. Footnote SiO3 questionable.

137 Delta-S .003 low at 4439db. Calc ok, 3 Autosal tries. Other water samples ok. Same value as 132 at level above. Possible dupe draw from bottle 32. No notes. Footnote salinity bad. ODF recommends deletion of salinity sample.

Station 034

121 Delta-S .003 low at 1770db. Calc & Autosal run ok. Other water samples ok. Smooth CTD traces this level. Footnote salinity questionable.

136 Delta-S .004 low at 5339db. Calc ok. 3 tries for Autosal. Other water samples ok. Smooth CTD traces. Footnote salinity bad.

138 Delta-S .003 low at 5045db. Calc & Autosal run ok. Other water samples ok. Smooth CTD traces. Footnote salinity questionable.

Station 035

132 Silicate appears 2.0 low at 3695db. Calc ok but peak poor. Other water samples ok. Footnote SiO3 questionable.

Station 036

103 Delta-S .021 high at 57db. 3 Autosal runs to get agreement. High gradient. CTD spike. Footnote CTD salinity bad. Bottle salinity agrees with adjoining stations, shows the same feature.

106 Delta-S .017 low at 132db. Calc & Autosal run ok. High gradient. CTD spike. Footnote CTD salinity bad.

126 Delta-S .003 high at 2187db. 4 Autosal runs to get agreement. Other water samples ok. Possible salt crystal contamination. Footnote salinity bad.

Station 038

Cast 1 All 36 trips indicated ok but surface bottle still open when ready to bring on board. Had to recycle pylon power to redo 36th trip (bottle 1). Data indicate no bottle at 4930db, deepest intended level and both bottles 1 & 2 closed at surface. All bottle data indicate bottles were closed one level higher than intended. Footnote bottle did not trip as scheduled. Adjusted CTD trip data.

Station 039

Cast 2 All silicate values appear 2 uM/L high. Apparent base line problem at start of AA run. sil look high compared to 038 & 040 plus 039 Gerard silicates but 036 & 037 sil look reasonably close. Footnote silicate questionable.

Station 040

129 Delta-S .006 high at 2621db. Calc ok, 3 Autosal tries for agreement. Same value as 130. Other water samples ok. Assume dupe draw from bottle 30. Footnote salinity bad.

134 Delta-S .003 low at 2621db. Calc & Autosal run ok. Same value as 137, one level above. Other water samples ok. Assume dupe draw from bottle 37. Footnote salinity bad.

Station 041

112 Delta-S .054 high at 359db. Calc & Autosal run ok. Same value as bottle 11 above. Other water samples have normal gradient. CTD S had no gradient between bottle 11 and bottle 12 levels. Large S spike on up trace. Bottle S ok. Large spike in CTD uptrace giving an erroneous salinity difference. Footnote CTD salinity bad.

132 Delta-S .0024 low at 2747db. Calc & Autosal run ok. Normal CTD gradient. Other water samples ok. Leave for now.

137 Delta-S .0027 high at 2952db. Calc & Autosal run ok. Normal CTD gradient. Other water samples ok. Leave for now.

Station 042

Cast 1 Nitrite not run because of colorimeter problem. Only 3 colorimeters available starting this station. Footnote NO2 lost.

108 PO4 appears high on pot temp-po4 plot, same value as level above. NO3 appears high on pot temp-no3 plot. same value as level above. SIL appears high

on pot temp-sil plot, same value as level above. Salinity has normal gradient. Oxygen is close to level above but CTDO is also close these levels. Possible dupe draw of nutrients from bottle 7. Footnote PO4, NO3, and SiO3 bad.

109 Delta-S .017 low at 109db. Calc & Autosal run ok. CTD S spike on up trace this level. bottle S ok. Footnote CTD salinity bad.

Station 043

Cast 1 Nitrite not run because of colorimeter problem. Only 3 colorimeters available starting last station. Footnote NO2 lost.

113 Sample log: "Air leak". Delta-S .0015 low at 308db. Other water samples also ok.

Station 044

Cast 1 Nitrites not run this station since only 3 colorimeters functioning. Footnote NO2 lost.

104 Delta-S .1 high at 80db. Calc & Autosal run ok. Same value as Sta 41 sample 104, last time this salt bottle used. Assume no salt drawn this station. Footnote salinity bad, analyst should have noticed that salinity sample was very low.

117 Salinity was scheduled to be drawn, but analyses was not performed. Footnote salinity lost.

Station 045

Cast 1 Nitrites not run this station since only 3 colorimeters functioning. Footnote NO2 lost.

105 Delta-S .028 low at 107db. Calc & Autosal run ok. T & S up trace spike. Bottle salt ok. Footnote CTD salinity bad.

106 Delta-S .040 low at 132db. Calc & Autosal run ok. T & S up trace spike. Bottle salt ok. Footnote CTD salinity bad. CTD Processor: "Discrete O2 at 132db looks slightly high compared to surrounding stations." Oxygen appears 0.7 high, reviewed data vs. pressure, potemp, and silicate. No sampling or analytical notes indicating a problem. Other data are acceptable. Footnote oxygen bad. No CTDO reported since CTD salinity is coded bad.

107 Delta-S .011 low at 158db. Calc & Autosal run ok. T & S up trace spike. Bottle salt ok. Footnote CTD salinity bad.

108 Delta-S .014 low at 183db. Calc & Autosal run ok. T & S up trace spike. Bottle salt ok. Footnote CTD salinity bad.

111 CTD Processor: "Discrete O2 at 309.1 db looks slightly high compared to surrounding stations." Oxygen appears 0.25 high. Footnote oxygen bad.

118 PO4 appears .08 high at 813db. Calc ok, peak poor but definitely high. Value is similar to PO4 max on most neighboring stations but NO3 doesn't match. Footnote PO4 questionable.

123 Delta-S .005 low at 1576db. Calc & Autosal run ok. Slight bump on CTD S up trace. Leave for now. Gradient, salinity is slightly low compared with adjoining stations. Footnote salinity questionable.

Station 046

Cast 1 Nitrites not run this station since only 3 colorimeters functioning. Footnote NO2 lost.

Cast 1 Data indicate no sample at deepest intended level and all bottles closed one level above intended level. Bottle 2 is surface bottle. Footnote bottle (2-

32,37,34,38,36) did not trip as scheduled. Profile appears to be acceptable at correctly reassigned pressures.

101 Sample log: "Did not close, no sample. Found ramp arm at 35 ready to trip position 36 (bottle 1) when preparing for next station." No notes on ConOps. Assigned bottle 1 the deepest pressure just for the CTD data. See Cast 1 tripping comment. Footnote bottle no samples drawn.

105 Delta-S .018 low at 80db. Calc & Autosal run ok. T spike on CTD up trace. Bottle salt looks ok. Footnote CTD salinity bad.

106 Delta-S .022 high at 106db. Calc & Autosal run ok. T spike on CTD up trace. Bottle salt looks ok. Footnote CTD salinity bad.

107 Delta-S .014 high at 132db. 4 Autosal runs for agreement. T spike on CTD up trace. Bottle salt looks ok. Footnote CTD salinity bad.

108 Delta-S .020 high at 157db. 3 Autosal runs for agreement. T spike on CTD up trace. Bottle salt looks ok. Footnote CTD salinity bad.

Station 047

Cast 1 Nitrites not run this station since only 3 colorimeters functioning. Footnote NO2 lost.

121-123 PO4 appears .05 high (863, 964 and 1167 db, respectively). Calc ok & peak fair. Similar problem at same general level on previous two stations. Footnote PO4 questionable.

Station 048

Cast 2 Nitrites not run this station since only 3 colorimeters functioning. Footnote NO2 lost.

234 Flask broken before titration. No bottle oxygen.

Station 049

Cast 1 Nitrites not run this station since only 3 colorimeters functioning. Footnote NO2 lost.

130 Sample log: "Leaking from bottom after air vent opened." Delta-S .000 at 2798db. Other water samples also ok.

137 Delta-S .004 high at 3462db. Calc & Autosal run ok. Other water samples ok. Possible draw or run error with salt bottle 33 drawn from 34 instead of 37 and salt bottle 34 drawn from 35 instead of 34. Corrected raw data file to reflect actual sample drawing order. Salinity was not drawn from this bottle.

134 Delta-S .003 high at 3719db. Calc & Autosal run ok. Other water samples ok. Possible draw or run error with salt bottle 33 drawn from 34 instead of 37 and salt bottle 34 drawn from 35 instead of 34. After correcting raw data file, salinity agreement acceptable.

Station 050

Cast 1 Tripped with 25 at bottom and 26 at top for freon bottle blank check.

137 Sample log: "bottom stopper leaked after air vent opened. Reseated ok." Delta-S .004 low at 182db. Other water samples also ok.

104 Delta-S .006 low at 408db. Calc & Autosal run ok. Same value as 3 at level above. Other water samples show normal gradient. Possible dupe draw or run. Footnote salinity bad.

Station 051

132 Delta-S .003 high at 3312db. Calc ok, 3 tries on Autosal. Other water samples ok. No notes, no obvious sampling error. Footnote salinity questionable. Feature could be real.

Station 053

108 Delta-S at 181db is -0.0571, salinity is 33.413. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

Station 054

109 Delta-S at 208db is -0.0313, salinity is 33.638. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

114 Sample log: "Lanyard caught in top end cap. Air leak. Delta-S .002 high at 409db. Other water samples also look ok. Oxygen and salinity agree with adjoining stations, bottle okay.

Station 056

Cast 1 All 36 trips indicated ok but surface bottle still open when ready to bring on board. Conops note:"trouble - took couple of tries" Data indicate no bottle at 4446db, deepest intended level, and both bottles 1 & 2 closed at surface. All bottle data indicate bottles were closed one level higher than intended. Adjusted CTD trip data and all samples are acceptable, unless noted otherwise. Footnote bottle did not trip as scheduled.

119 Sample log: "O-ring out of groove, air leak. Delta-S .025 low at 966db. Calc ok, 3 Autosal runs for agreement. Other water samples also seem to be from higher in water column. Footnote bottle leaking, samples bad. ODF recommends deletion of all water samples.

Station 057

Cast 1 CTD salinity trace noisy, brought back aboard, cleaned bio matter off conductivity cell, and sent down as cast 2 for complete cast with samples. Delta-Ss closer to those earlier in leg than more recent stations.

205 Delta-S at 109db is -0.0451, salinity is 33.042. Changing waters. Data okay. Spike in CTD up trace, footnote CTD salinity bad.

Station 058

228 Sample log: "C14 drawn after helium, before O2" Bottle oxy at 2542db looks good compared to CTDO and rest of bottle oxy profile. Oxygen is acceptable.

Station 059

105 Salinity data sheet: "Bottle 5 exploded, no data"

107 Ship's power failure during oxygen titration. Footnote oxygen lost.

Station 060

Cast 1 Bottles tripped for freon bottle blank check. bottle 13 is deepest level and bottle 14 is surface.

114 Sample log: "Air leak, lanyard caught in top end cap. Delta-S .000 at surface. Oxygen and salinity agree with adjoining stations, bottle okay.

118 Salinity value from Salt bottle 18 matches CTD salt from bottle 20. Assume drawing error. Footnote salinity bad, ODF recommends deletion of salinity sample.

120 Salinity value from Salt bottle 20 matches CTD salt from bottle 18. Assume drawing error. Footnote salinity bad, ODF recommends deletion of salinity sample.

Station 062

221 Delta-S .003 low at 1523db. Calc ok but 5 Autosal runs to get agreement. Other water samples ok. Suspect salt crystal. Footnote salinity bad.

229 Delta-S .004 low at 2925db. Calc ok but 4 Autosal runs to get agreement. Other water samples ok. Footnote salinity bad.

Station 063

115-120 Nitrate appears 1.5 µM/L low. PO_4 had problem this area and was rerun but nothing out of ordinary re NO_3. These bottles were also slightly lower than adjacent stations on previous cast (062/02) then go back to normal on next station (064/01). Footnote NO_3 questionable.

Station 064

136 Delta-S .01 low at 4747db. Calc & Autosal run ok All water samples indicate bottle 36 closed higher in water column. ODF recommends deletion of all water samples. Footnote bottle leaking, samples bad.

Station 065

105 Sample log: "O-ring not seated, air leak." Delta-S .02 low at 107db. High gradient. Other water also look ok for high gradient.

Station 066

Cast 1 All bottles closed when brought to surface for surface sample. Data indicate bottles 4 & 5 both closed at 108db. Footnote bottles 1 through 5 did not trip as scheduled.

101-105 See Cast 1 bottle comment. Footnote bottle did not trip as scheduled.

Station 067

Cast 1 Bottle 1 still open after trip 36 confirmed. Data indicates no sample at deepest intended level and all bottles closed one level higher than intended with both bottles 1 & 2 closed at surface. Footnote bottle did not trip as scheduled.

116 Delta-S 1.3 low at 611db. All water samples indicate bottle 16 closed at surface. O_2 draw temp low so probably closed when rosette first entered water. Footnote bottle leaking, samples bad. ODF recommends deletion of all water samples.

124 O_2 appears 0.3 high at 2033db. Calc & titration look ok. No notes. Value goes much better with level below (125). Possible drawing or running error. Footnote oxygen bad.

125 O_2 appears 1.3 high at 2134db. Comment on O_2 data sheet: "chk, air delivered (3) 0.35152" Footnote oxygen bad.

Station 068

206 Delta-S at 132db is -0.0437, salinity is 33.207. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

209 Dissolved oxygen appears 3.7 high at 208db. Nutrients ok. Delta-S .000. Oxygen value higher than max this station. Titration problem?, no notes. Footnote oxygen bad.

Station 071

121-123 Delta-Ss .004 high at 1469-1928db. Reruns indicate original bottle salts wrong but too much scatter to use rerun data. Footnote salinity bad.

132 Delta-S .003 low at 3847db. Calc & Autosal run ok. Same value as bottle 31 at level above. Possible dupe draw or run. Rerun indicates original bottle salt run in error. Footnote salinity bad.

Station 072

128 Delta-S .013 high at 2802db. Other water samples also indicate deeper than intended. Footnote bottle leaking, samples bad. ODF recommends deletion of all water samples.

137 Delta-S .003 low at 4090db. Other water samples ok. Same value as bottle 32 at level above. Possible dupe draw or run. Footnote salinity bad.

Station 073

101-105 CTD Processor: "CTD O2 "questionable" 0 - 130 db."

Station 075

105 Delta-S at 110db is -0.0324, salinity is 33.250. Large gradient. Data okay. Spike in CTD up trace, footnote CTD salinity bad.

Station 076

106 Delta-S at 132db is 0.083, salinity is 33.272. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

117 Titration problem. No dissolved oxygen. Other samples ok. Footnote oxygen lost.

130 Sample log: "Cap broken away from spring and chipped. Bottom cap hooked to bottle 31 btm lanyard." Lanyard from bottom end cap to spring missing. No water samples.

Station 077

Cast 1 Tripped bottle 25 at bottom, bottle 26 at top for freon bottle blank check.

137 Sample log: "leaking from bottom seal" Assume leaking from bottom end cap after air vent opened. Delta-S .000 at 185db. Other water samples also look ok.

108 O-ring out of groove on bottom end cap. No water samples.

Station 078

223 Sample log: "No sample (Bottom lanyard got caught)."

Station 080

Cast 1 Delta-Ss all .005 to .007 high. Slime on CTD sensors. All water samples look ok.

120 Delta-S at 1120db is 0.0066, salinity is 34.432. See Cast 1 salinity comments. Footnote CTD salinity bad.

121 Delta-S at 1324db is 0.0089, salinity is 34.485. See Cast 1 salinity comments. Footnote CTD salinity bad.

122 Delta-S at 1526db is 0.0081, salinity is 34.519. See Cast 1 salinity comments. Footnote CTD salinity bad.

123 Delta-S at 1731db is 0.0059, salinity is 34.550. See Cast 1 salinity comments. Footnote CTD salinity bad.

124 Delta-S at 1935db is 0.0065, salinity is 34.576. See Cast 1 salinity comments. Footnote CTD salinity bad.

125 Delta-S at 2138db is 0.007, salinity is 34.597. See Cast 1 salinity comments. Footnote CTD salinity bad.

126 Delta-S at 2342db is 0.0054, salinity is 34.613. See Cast 1 salinity comments. Footnote CTD salinity bad.

127 Delta-S at 2546db is 0.0074, salinity is 34.630. See Cast 1 salinity comments. Footnote CTD salinity bad.

128 Delta-S at 2752db is 0.0069, salinity is 34.643. See Cast 1 salinity comments. Footnote CTD salinity bad.

129 Delta-S at 2957db is 0.0076, salinity is 34.652. See Cast 1 salinity comments. Footnote CTD salinity bad.

130 Delta-S at 3213db is 0.007, salinity is 34.661. See Cast 1 salinity comments. Footnote CTD salinity bad.

131 Delta-S at 3471db is 0.0082, salinity is 34.669. See Cast 1 salinity comments. Footnote CTD salinity bad.

132 Delta-S at 3727db is 0.0079, salinity is 34.675. See Cast 1 salinity comments. Footnote CTD salinity bad.

137 Delta-S at 3983db is 0.0088, salinity is 34.680. See Cast 1 salinity comments. Footnote CTD salinity bad.

134 Delta-S at 4292db is 0.0088, salinity is 34.682. See Cast 1 salinity comments. Footnote CTD salinity bad.

138 Delta-S at 4550db is 0.0086, salinity is 34.685. See Cast 1 salinity comments. Footnote CTD salinity bad.

136 Delta-S at 4713db is 0.0095, salinity is 34.686. See Cast 1 salinity comments. Footnote CTD salinity bad. CTD Processor: "Discrete O2 at 4713.3 db (bottle 36) looks slightly high compared to surrounding stations (ok if look at theta/O2)." No CTDO reported since CTD salinity is coded bad.

Station 081

134 Delta-S .006 high at 4239db. Calc ok but 4 Autosal runs to get agreement. 4th run .00003 higher than 3rd. Other water samples ok. Assume salt crystal from cap fell in sample. Footnote salinity bad.

Station 083

117 Sample log: "Air leak, top end cap reseated, ok. Delta-S .001 low at 809db. Other water samples also ok.

121 Delta-S .03 high at 1525db. Calc & Autosal run ok. Same value as bottle 22 salt at level below. Reran both salt bottles, got same results so probably dupe draw not dupe run. Other water samples ok. Footnote salinity bad.

137 Sample log: "Dripping from bottom end cap after air vent opened." Delta-S .000 at 3820db. Other water samples also ok.

Station 084

107 Delta-S at 158db is 0.0643, salinity is 33.546. Large gradient. Data okay. Spike in CTD up trace, footnote CTD salinity bad.

Station 085

105 Delta-S at 107db is 0.0591, salinity is 33.086. Large gradient. Data okay. Spike in CTD up trace, footnote CTD salinity bad.

106 Delta-S at 132db is 0.039, salinity is 33.651. Large gradient. Data okay. Spike in CTD up trace, footnote CTD salinity bad.

Station 086

205 Delta-S at 108db is -0.0545, salinity is 33.049. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

209 Sample log: "Air valve not closed." Delta-S .021 high at 210db. 6 Autosal runs to get agreement. Small salinity spike on CTD up trace. Down CTD T & S differ from up values. Other water samples look ok in high gradient area. Footnote CTD salinity bad.

Station 087

103 Delta-S at 58db is -0.0289, salinity is 32.581. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

Cast 2 Repeat cast with LADCP to 5500db only. Salinities were only samples drawn. CTD Processor: "No discrete oxygens - use fit from 087/01)." Footnote CTD O2 questionable.

Station 088

106 Delta-S at 132db is 0.0544, salinity is 33.510. Large gradient. Data okay. Spike in CTD up trace, footnote CTD salinity bad.

134 Sample log: stopcock found fully opened" Delta-S .000 at 5011db. Other water samples also ok.

Station 089

107 Sample log: "Bottom lanyard unhooked" Delta-S .010 high at 158db. Calc & Autosal run ok. Other water samples also look ok at high gradient and differing up & down CTD T & S traces.

Station 090

104 Sample log: "Air vent open." Delta-S .001 high at 82db. Other water samples also look ok.

111 Delta-S .07 low at 283db. Calc & Autosal run ok. Same value as bottle 10 at level above. Other water samples ok. Assume dupe draw or run. ODF recommends deletion of salinity sample. Footnote salinity bad.

137 Sample log: "Leaking from bottom end cap after air vent opened. Top cap reseated." Delta-S .001 high at 3954db. Other water samples also ok.

Station 091

101 Delta-S .02 low at 3db. Calc ok, 3 Autosal runs. Bottle salt looks ok. Spike on CTD up trace this level. Footnote CTD salinity bad.

117 Delta-S .09 high at 561db. Calc ok, 3 Autosal runs. Bottle salt looks ok. Spike on CTD up trace this level. Footnote CTD salinity bad.

137 Sample log: "Leaked from bottom end cap after air vent opened. Reseated, ok." Delta-S .000 at 3365db. Other water samples also ok.

Station 092

106 Delta-S .08 high at 131db. Calc ok, 3 Autosal runs. High gradient and CTD up trace spike at this level. Footnote CTD salinity bad. Bottle salt and other water samples look ok.

108 Delta-S .04 high at 181db. Calc & Autosal run ok. Same value as bottle 9 at level below. Other water samples ok. Assume dupe draw or run. ODF recommends deletion of salinity sample. Footnote salinity bad.

137 Sample log: "Leaked from bottom end cap after air vent opened. Reseated, ok." Delta-S .000 at 2954db. Other water samples also ok.

Station 093

103 Delta-S at 55db is 0.0335, salinity is 32.634. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

Station 094

114 Delta-S .04 high at 106db. Calc & Autosal run ok. Bottle salt looks ok. CTD up-trace spike this level. Footnote CTD salinity bad.

Station 095

137 Sample log: "Leaks from bottom end cap after air vent opened. Reseated, ok." Delta-S .000 at 1311db. Other water samples also ok.

Station 096

138 Sample log: "Leaks from bottom end cap after air vent opened. Reseated, ok." Delta-S .002 low at 1365db. Calc & Autosal run ok. Other water samples appear ok. Normal CTD gradient.

Station 097

121 Delta-S .04 low at 155db. Calc & Autosal run ok. All water samples ok. CTD S spike on up trace this level. Footnote CTD salinity bad.

127 Sample log: "Did not close, bottom lanyard hangup." No water samples.

137 Sample log: "Leaks from bottom end cap after air vent opened. Reseated, ok." D lta-S .001qlow at 711db. Other water samples also ok.

Station 098

107 Sample log: "Bottom lanyard unhooked" Delta-S .017 high at 155db. Calc & autosal run ok. Other water samples also ok in high gradient area.

109 Delta-S .09 low at 205db. Calc & Autosal run ok. Bottle salt looks ok. CTD S up trace spike this level. Footnote CTD salinity bad.

Station 099

101 Delta-S .05 low at 3db. Calc & Autosal run ok. High gradient. Spike in CTD up trace, footnote CTD salinity bad.

Station 122

137 Sample log: "Leaks from bottom end cap after air vent opened. Reseated, ok." Delta-S .000 at 3777db. Other water samples also ok. Replaced bottle 37 with bottle 33 after this cast.

Station 123

117 No bottle oxygen. Titration problem. Footnote oxygen not reported.

132 Delta-S .002 low at 3571db. Calc & Autosal run ok. Other water samples ok. Same sampler had low salinity on next station. Had been ok on prior stations. Footnote salinity questionable, not within accuracy of measurement.

Station 124

105 Delta-S at 107db is -0.0374, salinity is 33.557. Large gradient. Data okay. Spike in CTD trace, footnote CTD salinity bad.

128 Delta-S 0.006 low at 2751db. Calc & Autosal run ok. Other water samples ok. Rerun is .006 higher indicating problem was with original Autosal run. Footnote salinity questionable.

132 Delta-S 0.003 low at 3695db. Calc & Autosal run ok. Other water samples ok. Rerun is .001 higher indicating original Autosal run was ok. Delta-S this sampler was 0.002 low on previous station. Had been ok on prior stations. Bottle 32 salinities ok subsequent stations. Footnote salinity questionable.

Station 125

101 All surface data differ from adjacent stations, temp & oxygen high and salinity and nutrients low. Calc ok. Spring bloom? CTD Processor: "Surface discrete O2 (2.7 db, bottle 01) looks high compared to surrounding stations." Footnote CTD O2 questionable.

Station 126

105 Delta-S at 106db is -0.036, salinity is 33.120. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

106 Delta-S at 132db is -0.0424, salinity is 33.381. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

124-129 CTD Processor: "Discrete (& thus also CTD) O2's don't look like surrounding stations from about 1700 to 3000 db (looks ok if look at theta/O2)." Footnote CTD O2 questionable.

Station 127

112 Bottle oxygen appears high compared to CTDO down trace but look good compared to up trace. CTD Processor: "Discrete O2 at 363.5 db (bottle 12) looks high compared to surrounding stations, although looks just fine if look at CTD O2 up trace." Footnote CTD O2 questionable.

Station 130

109 Sample log: "Air leak, vent not tight." Delta-S .00 at 206db. Other water samples also look ok.

117 Sample log: "Air leak, top cap cracked." Delta-S .003 low at 610db. Other water samples look ok. Down & up traces differ somewhat this level.

Station 131

Cast 1 Tripped bottle 17 at bottom, bottle 18 at top, for freon bottle blank check.

Station 132

218 Delta-S .04 high at 812db. Calc ok, 3 Autosal runs. Same value as bottle 19 at level below. Assume dupe draw or run. Salt box used for subsequent station so rerun not possible. Other water samples ok. Footnote salinity bad.

Station 136

122 Delta-S .003 high at 912db. Calc & Autosal run ok. Other water samples look ok at O2 min & PO4 max. Normal CTD gradient up and down. Footnote salinity questionable.

Station 137

Cast 1 Pylon program problem, no bottle closed at 611db, all remaining bottles closed one level higher than intended. Two bottles open at surface, both tripped and sampled. Footnote bottles 1 through 18 did not trip as scheduled.

107 Delta-S at 131db is -0.0269, salinity is 33.234. Large gradient. Data okay. Spike in CTD up trace, footnote CTD salinity bad.

108 Delta-S at 155db is 0.0113. Large gradient. Data okay. Spike in CTD up trace, footnote CTD salinity bad.

Station 138

105 Delta-S at 106db is -0.0293, salinity is 32.722. Large gradient. Data okay. Spike in CTD uptrace, footnote CTD salinity bad.

Station 139

101-102,104-117 CTD Processor: "Discrete (& thus also CTD) O2's don't look like surrounding stations for top 800 db (looks ok if look at theta/O2)." Footnote CTD O2 questionable.

103 Delta-S at 55db is -0.0513, salinity is 32.261. Large gradient. Data okay. Spike in CTD uptrace, footnote CTD salinity bad. See 101 CTD Processor comment. No CTD Oxygen since CTD salinity is coded bad.

Station 140

106 Delta-S at 130db is 0.0464, salinity is 32.980. Large gradient. Data okay. Spike in CTD uptrace, footnote CTD salinity bad.

127 Sample log: "Did not close, lanyard is too tight." Bottom lanyard hung-up, no water sample. Not adjusted after LADCP installation.

Station 141

206 Delta-S at 131db is 0.0441, salinity is 33.126. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

207 Delta-S at 156db is 0.0327, salinity is 33.387. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

227 Delta-S .003 high at 1523db. Calc ok but 5 Autosal runs to get agreement. Other water samples ok, & normal CTD S trace down and up. Assume salt crystal from cap in sample. Footnote salinity bad.

Station 142

103 Sample log: "Lower end cap leaking when air vent opened." Delta-S .004 high at 56db. Other water samples also look ok.

108 Delta-S at 182db is 0.0302, salinity is 33.427. Large gradient. Data okay. Spike in CTD uptrace, footnote CTD salinity bad.

Station 143

108 Delta-S at 180db is 0.0321, salinity is 32.908. Large gradient. Data okay. Spike in CTD uptrace, footnote CTD salinity bad.

109 Delta-S at 206db is 0.0315, salinity is 33.209. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

110 Delta-S at 231db is 0.0337, salinity is 33.435. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

Station 144

102 Delta-S at 29db is 0.0269, salinity is 32.222. Large gradient. Data okay. Spike in CTD uptrace, footnote CTD salinity bad.

105 Delta-S .06 low at 106db. Calc & Autosal run ok. CTD S spike this level, footnote CTD salinity bad..

106 Delta-S at 130db is -0.0295, salinity is 32.705. Large gradient. Data okay. Spike in CTD uptrace, footnote CTD salinity bad.

107 Delta-S at 158db is -0.0304, salinity is 33.041. Large gradient. Data okay. Spike in CTD uptrace, footnote CTD salinity bad.

117 Sample log: "Air leak, chip from top cap caught under o- ring." Delta-S .00 at 408db. Other water samples also look ok.

Station 146

117 PO4 0.5 high at 2db. NO3 9.0 high at 2db. SiO3 3.0 high at 2db. Same value as bottle 20 3 levels below. Rerun confirms, assume bad draw. Other water samples okay. Footnote nutrients bad.

Station 147

127 Delta-S at 154db is -0.0656, salinity is 32.755. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

136 Salinity was drawn per Sample Log sheet, however, sample was not run. Other salinity samples are reasonable, suspect that this salinity was not just analyzed. Footnote salinity lost.

Station 148

129 Delta-S at 28db is -0.0267, salinity is 31.935. Footnote CTD salinity bad due to spike in CTD uptrace. Bottle salinity acceptable.

Appendix D

LVS Quality Comments

Remarks for missing samples, and WOCE codes other than 2 from WOCE P17N Large Volume Samples. Investigation of data may include comparison of bottle salinity and silicate data from piggyback and Gerard with CTD cast data, review of data plots of the station profile and adjoining stations, and rereading of charts (i.e., nutrients). Comments from the Sample Logs and the results of ODF's investigations are included in this report. Units stated in these comments are micromoles per liter for Silicate unless otherwise noted. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR). PB refers to the bottle that is attached to the Gerard.

Station 010

142 Sample log: "Not closed. Trip arm missed Push Rod." No samples, no temperature. Gerard (82) appears to be okay.

143 SiO3 appears 2.0 low at 3251db. Calc ok, peak fair, but definitely low. Other water samples ok. Salts agree with rosette. Footnote SiO3 questionable. Gerard (83) appears to be okay.

144 SiO3 appears 3.0 low at 3404db. Calc ok, peak fair, but definitely low. Gerard silicate with 44 closer to normal. Footnote SiO3 questionable. Gerard (84) appears to be okay.

182 PB 42, Gerard appears to be okay. No temperature.

183 SiO3 appears 3.0 low at 3252db. Calc ok, peak fair, but definitely low. Other water samples ok. Salts agree with rosette. Footnote SiO3 questionable. PB 43, Gerard appears to be okay.

347 Gerard (89) leaked, see Gerard comments. NO3 & PO4 are high. PI to decide barrel intergrity.

389 Delta PB-Gerard Salinity = .021 at 2727db. Gerard salt looks low compared to other levels this cast and to rosette cast this station. However Gerard nutrients look ok and PB (47) NO3 & PO4 look high? Nutrient sample numbers were incorrectly assigned. After correction, no3 high by 1.4, and PO4 high by .08. SiO3 low by .2, which is within the accuracy of the measurement. Footnote salinity and nutrients all except SiO3 questionable, and bottle leaking. PI to decide barrel integrity.

Station 028

147 Delta PB-Gerard salt .835 low at 4787db. Nutrients also indicate PB tripped near surface. Therm rack ok. Gerard 89 salinity & nutrients look good. Delta-S PB-Gerard at 4787db is -0.835, salinity is 33.851. Footnote bottle leaking, samples bad. Gerard (89) is okay.

183 Sample Log: "Air leak. Loose fitting at bottom." Delta PB- Ger salt .0001. Nutrients also match well. PB 43. Gerard is okay.

193 Sample Log: "Very slight air leak." Delta PB-Ger salt .0005. Nutrients also match well. PB 49. Gerard is okay.

347 PB failed to trip. Trip rod not down far enough to release lanyards. Gerard 89 salt & nutrients look good. No samples, no temperature. Gerard is okay.
382 Sample Log: "Top valve loose." Delta PB-Ger salt .0008. Nutrients also match well. PB 42. Gerard is okay.
383 Sample Log: "Significant air leak." Delta PB-Ger salt .0002. Nutrients also match well. PB 43. Gerard is okay.
389 No temperature see PB 47 comment. Gerard is okay.
393 Sample Log: "Slow air leak". Delta PB-Ger salt .0005. Nutrients also match well. PB 49. Gerard is okay.

Station 039
141 Gerard (81) is reasonable, PI may want to double-check. Delta-S PB-Gerard at 3464db is 0.0031, salinity is 34.669. See 181 comments Gerard is questionable. Gerard (81).
142 Temp appears .03 high. PB water samples agree with rosette. PB water samples appear deeper than Gerards, while temp is shallower. Apparent rack posttrip. NO3 is .2 high, which is within the specs of the measurement. Delta-S PB-Gerard at 3641db is 0.0065, salinity is 34.673. See 182 comments, Gerard (82), footnote temperature questionable.
144 Temp appears .03 high. PB water samples agree with rosette. Footnote temperature questionable. Gerard (84) is okay.
181 Sample log: "Air Vent open." Delta PB-Ger salt = .003 at 3464db. Calc & Autosal runs ok. NO3 same, PO4 indicates Gerard has shallower water but most PO4 comparisons have higher Gerard values than PBs. Suspect bottle okay, salinity difference is not that unreasonable. PI will have to make final determination on this sample. PB 41.
182 Sample log:"Air vent open." Delta PB-Ger salt = .0065 at 3641db. Salinity calc & Autosal runs ok. Nutrient differences inconclusive. Footnote bottle leaking, salinity and temperature questionable. See PB 142 temperature comment. PI will have to make final determination on this sample. PB (42).
183 Sample log: "Air leak." Delta PB-Ger salt .0016 at 3818db. Salinity calc & Autosal runs ok. Nutrients reasonable. PB (43).
184 Delta PB-Ger salt .0006 at 3996db. Nutrients reasonable. Footnote temperature questionable, see PB 144 temperature comment.
341 Gerard (93) is okay.
387 Sample log: "Slow air leak." Delta PB-Ger salt = .0004 at 2727db. Nutrients also ok. PB 44. Gerard is okay.
393 Sample log:"Slow air leak." Delta PB-Ger salt = .0006 at 3294db. Nutrients also ok. PB 41. Gerard is okay.

Station 048
141 Delta-S PB-Gerard at 3024db is 0.003, salinity is 34.659. Gerard (81) indicates a slight leak.
142 Sample log: "Slight air leak. Reseated top, ok" Gerard (82).
145 Delta-S PB-Gerard at 3534db is 0.002, salinity is 34.670. See Gerard (85) SiO3 comment. Footnote SiO3 questionable.

146 Footnote SiO3 questionable. See 185 comments. Gerard (87) is okay.

147 Sample log: "Light air leak. Reseated top, ok." Delta PB- Ger salt .001 at 3838db. Nutrients also look ok. Gerard (89) is okay. Footnote SiO3 questionable. See 185 comments.

148 Gerard (90) is okay. Footnote SiO3 questionable. See 185 comments.

149 Footnote SiO3 questionable. See 185 comments. Gerard (93) is okay.

181 Sample log: "Air vent loose. Went down tight per DM & RR." Delta PB-Ger .003 at 3024db. Nutrients look reasonably close. Very slight sample leak if any. Footnote Gerard leaking, but data acceptable, let PI make final decision. PB 41.

182 Sample log: "Air vent just barely tight. No air leak." Delta PB-Ger .001 at 3151db. Nutrients also ok. PB 42.

185 Sample log: "Air vent slightly loose. V. slow air leak." Delta PB-Ger salt .002 at 3534db. PO4 & SIL also indicate very slight leak. PB 45. Gerard is probably okay, but PI should double check. Footnote bottle leaking. SiO is ~-0.2 low compared to rosette cast, do not suspect a problem with the Gerard barrel, but rather the SiO3 analysis. From this sample to the deepest there appears to be a ~-0.2 offset. Footnote SiO3 questionable.

187 Sample log: "Air vent slightly loose. V. slow air leak." Delta PB-Ger salt .001 at 3686db. Nutrients also look ok. PB 46. Footnote SiO3 questionable. See 185 comments.

189 Footnote SiO3 questionable. See 185 comments. PB 47.

190 Footnote SiO3 questionable. See 185 comments. PB 48.

193 Sample log: "V. slow air leak." Delta PB-Ger salt .001 at 4144db. Nutrients also look ok, taking into account SiO3 problem. PB 49. Footnote SiO3 questionable. See 185 comments.

Cast 3 PB sample numbers for salinity were not filled in. Wrote in numbers 1-9. Salinities appear to be okay. Nitrites not run this station since only 3 colorimeters functioning. Footnote NO2 lost.

341 PO4 appears .04 low at 1911db compared to Gerard and rosette profile. Calc & peak ok. Used 2nd of 2 samples from 41 to account for large jump from SSW to deep nutrient values. Other nutrients and salt ok. PO4 is questionable. Gerard (81) is okay.

385 Sample log: "Slight air leak." Delta PB-Ger Salt .0002 at 2420db. Nutrients also have good agreement. Gerard is okay. PB 45.

390 Delta PB-Ger salt .004 at 2800db. Calc & autosal runs ok. Excellent agreement between nutrients. PB salt matches rosette salt better than Gerard salt. Footnote salinity questionable. Gerard is okay. PB 48.

393 Sample log: "Air leak." Delta PB-Ger salt .0004 at 2924db. Nutrients also have good agreement. Gerard is okay. PB 49.

Station 058

141 Sample log: "Air leak, reseated top, ok." Delta PB-Ger salt .001 at 3148db. Nutrients from PB also okay, although Gerard PO4 is .04 high. Gerard (81) is okay.

142 DSRT rack reversed late, no temperature. Thin lanyard pulled into release pin hole. Replaced rack lanyard after this station. Gerard (82) is okay.

181 PO4 .04 high at 3148db compared to rest of Gerard PO4 profile and about .02 high compared to rosette profile this level. Delta PB-Ger salt .001 and other nutrients ok. PB 41.
182 No temperature see PB 42 comment. Gerard is okay.
342 DSRT rack reversed late, no temperature. Thin lanyard pulled into release pin hole. Replaced rack lanyard after this station. Gerard (82) is okay.
382 No temperature, see PB 42 comment, Gerard is okay.
383 Sample log: "Air leak." Delta PB-Ger salt .0007 at 2217db. Nutrients also ok. PB 43, gerard is okay.
384 Sample log: "Slow air leak." Delta PB-Ger .0003 at 2342db. Nutrients also ok. PB 44, Gerard is okay.
385 Sample log: "Slow air leak." Delta PB-Ger .0003 at 2468db. Nutrients also ok. PB 45, Gerard is okay.
393 Sample log: "Slow air leak." Delta PB-Ger salinity = .005 at 2975db. Calc & Autosal runs ok. Nutrients all agree well. PB salt higher and Gerard salt lower than rosette salinity this level. PB 49, Gerard is probably okay, let PI decide.

Station 068
141 Delta PB-G S=.003. Calc & Autosal runs ok. PB slightly higher & Ger slightly lower than rosette trace. Nitrates & silicates agree. Ger PO4 a little high as usual. Footnote salinity questionable. Suspect Gerard (81) is okay.
146 Delta PB-G S=.004 at 4188db. Calc & Autosal runs ok. Gerard salt appears low compared to other samples & rosette trace. Nutrients agree reasonably well. Gerard (87) is okay.
149 Delta PB-G S=.003 at 4730db. Calc & Autosal runs ok. Gerard salt appears low compared to other samples & rosette trace. Nutrients agree reasonably well. Suspect Gerard (93) is okay.
181 Delta PB-G S=.003. Calc & Autosal runs ok. PB slightly higher & Ger slightly lower than rosette trace. Nitrates & silicates agree. Ger PO4 a little high as usual. Footnote salinity questionable. Suspect Gerard is okay, PB 41.
187 Delta PB-G S=.004 at 4188db. Calc & Autosal runs ok. Gerard salt appears low compared to other samples & rosette trace. Nutrients agree reasonably well. Footnote salinity questionable, not within specification of measurement. PB 46, Gerard is okay.
193 Delta PB-G S=.003 at 4730db. Calc & Autosal runs ok. Gerard salt appears low compared to other samples & rosette trace. Nutrients agree reasonably well. Footnote salinity questionable. Suspect Gerard is okay, PB 49.
341 Delta PB-Ger Salt diff -.005. Ger S fits profile & rosette. PB seems low. Footnote salinity questionable. Gerard (81) is okay.
343 Delta-S PB-Gerard at 2220db is -0.0021, salinity is 34.599. Gerard (83) is okay.
381 Delta PB-Ger Salt diff -.005. Ger S fits profile & rosette. PB seem low. Nutrients have good agreement between Ger & PB. PB 41, Gerard is okay.
383 Sample log: "Air leak." Delta PB-Ger S =-.002. Gerard salt matches profile & rosette salts better than PB. Nutrients have good agreement between Ger & PB. Gerard is okay, PB 43.
385 Sample log: "Slow air leak." Delta PB-G S=-.001. Nutrients also agree. PB 45.

387 Sample log: "Slow air leak." Delta PB-G S=.001. Nutrients also agree. PB 46.
393 Sample log: "Slow air leak." Delta PB-G S =.000. Nutrients also agree. PB 49.

Station 078

185 Sample log: "Slow air leak." Delta PB-Ger Salt = .0001 at 4192db. NO3 & SIL also ok. Gerard PO4 .04 high but Gerard PO4s are usually high. Gerard sample looks ok. PB 45.
187 Sample log: "Slow air leak." Delta PB-Ger Salt = .0009 at 4370db. Nutrients also ok. PB 46.
193 Sample log: "Slow air leak." Delta PB-Ger Salt = -.0009 at 4903db. Nutrients also ok. PB 49.
385 Sample log: "Slow air leak." Delta PB-Ger Salt = .0007 at 2415db. NO3 & Sil also ok. Gerard PO4 .03 high but Gerard PO4s are usually high. Gerard sample looks ok. PB 45.
387 Sample log: "Slow air leak." Delta PB-Ger Salt = .0003 at 2592db. Gerard nutrients also ok. PB NO3 & SIL a little low this level (346) PB 46.
393 Sample log: "Slow air leak." Delta PB-Ger Salt = .0005 at 3133db. Nutrients also ok. PB 49.

Station 086

Cast 1 PB sample numbers for nuts and salinity were not filled in. Wrote in numbers 1-9. Samples appear to be okay.
145 Delta-S(PB-g) at 4812db is 0.0027, salinity is 34.688. Suspect Gerard (85) is okay.
148 PO4 .08 high at 5428db. Calc & peak ok. Delta PB-Ger salt = -.0004, other nutrients and Gerard PO4 ok. Assume PO4 contamination PB 48. Gerard (90) is okay.
183 Sample log: "Slow air leak." Delta PB-Ger Salt = .0009 at 4299db. Nutrients also ok. PB 43.
185 Sample log: "Major air leak." Delta PB-Ger Salt = .0027 at 4812db. Gerard salt looks low compared to other salts this station. However, nutrients have reasonably good agreement this level. Footnote salinity questionable. Suspect Gerard is okay, PB 45.
187 Sample log: "Slow air leak." Delta PB-Ger Salt = .0005 at 5018db. Nutrients also ok. PB 46.
346 Suspect Gerard (87) is okay. Delta-S PB-Gerard at 2900db is 0.0023, salinity is 34.655. Footnote salinity questionable.
385 Sample log: "Slow air leak." Delta PB-Ger Salt = .0005 at 2722db. Nutrients also ok. PB 45.
387 Sample log: "Slow air leak." Delta PB-Ger Salt = .0023 at 2900db. Nutrients look ok. Difficult to tell which salt looks better because of gradient. Footnote salinity questionable. Suspect Gerard is okay, PB 46.

Station 132

146 Delta-S PB-Gerard at 3759db is 0.002, salinity is 34.677. Footnote salinity questionable. Gerard (87) is acceptable.

147 PO4 .08 high at 3912db. Peak ok. Delta PB-Ger salt .001 and other nutrients ok. Gerard PO4 looks good. Assume PO4 contamination in PB 47. Gerard (89) is acceptable.

347 Sample log: "Air leak, reseated top, ok." Delta PB-Ger salt .001 at 2569db. Nutrients also ok. Gerard (89) is acceptable.

389 PB 47. Gerard samples are acceptable.

Station 141

Cast 1 Silicate has a problem, other water properties ok. All silicate values about 2.0 lower than rosette silicates. Nothing obvious in data. AA controller did not sample third end SW but final SW adjusted based on difference between 2nd & 3rd SW on adjacent station.

141 All silicate values about 2.0 lower than rosette silicates. Footnote SiO3 questionable. See Cast 1 SiO3 comment. Gerard (81) is acceptable.

142 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (82) is acceptable.

143 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (83) is acceptable.

144 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (84) is acceptable.

145 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (85) is acceptable.

146 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (87) is acceptable.

147 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (89) is acceptable.

148 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (90) is acceptable.

149 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Delta- S PB-Gerard at 3338db is 0.002, salinity is 34.672. Gerard (93) is acceptable.

181 See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 41, Gerard is okay.

182 Sample log: "Major air leak." Delta PB-Ger salt .002 at 2466db. Calc & Autosal run ok. Gerard salt appears slightly low. Nutrients agree well. See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 42. Gerard is acceptable.

183 See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 43, Gerard is okay.

184 See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 44, Gerard is okay.

185 Sample log: "Slight air leak." Delta PB-Ger salt .001 at 2724db. Calc & Autosal run ok. Nutrient agreement also reasonable. See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 45. Gerard is acceptable.

187 Sample log: "Moderate air leak." Delta PB-Ger salt .0014 at 2876db. Calc & Autosal run ok. Nutrient agreement also reasonable. See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 46. Gerard is acceptable.

189	See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 47, Gerard is okay.
190	See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 48, Gerard is okay.
193	See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 49, Gerard is okay.
Cast 3	Deeper silicate values up to 1.0 higher than rosette sil. See Cast 1 nutrient comments.
347	Deeper silicate values up to 1.0 higher than rosette sil. See Cast 3 SiO3 comment. Footnote SiO3 questionable. Gerard (89) is okay.
348	See Cast 3 SiO3 comment. Footnote SiO3 questionable. Gerard (90) is acceptable.
349	See Cast 3 SiO3 comment. Footnote SiO3 questionable. Gerard (93) is acceptable.
389	See Cast 3 SiO3 comment. Footnote SiO3 questionable. PB 47, Gerard is okay.
390	See Cast 3 SiO3 comment. Footnote SiO3 questionable. PB 48, Gerard is okay.
393	See Cast 3 SiO3 comment. Footnote SiO3 questionable. PB 49, Gerard is okay.

P17N
Final Report
for Large Volume Samples

Robert M. Key
July 11, 1996

1.0 General Information

WOCE section P17N (expedition designation Voyage TTO21; Expocode 325021/1) was carried out aboard R/V Thomas G. Thompson during the period May 15 – June 26, 1993. The cruise began at San Francisco, CA and ended at Sitka, AK. David Musgrave of Univ. of Alaska was chief scientist. This report covers details of data collection and analysis for the large volume Gerard samples. The reader is referred to the final cruise report prepared by Musgrave (1995) as the primary source for cruise information. Portions of this report were taken from the SIO-ODF data report.

Ten large volume (LV) stations were occupied on this leg. The cruise plan called for 2 Gerard casts of 9 barrels each at each LV station. The planned sampling density was 1 station every 5° of latitude (~300nmi). Each station included at least one deep cast (2500db to the bottom), and an intermediate (1200db to 2500db) cast. There were no Gerard barrel mistrips on this cruise which were apparent at the end of the cast. The purpose of these casts was to collect samples for ^{14}C analysis. ^{14}C coverage for the upper water column was done *via* small volume AMS sampling from the Rosette. AMS sampling was carried out jointly by P. Quay (U. Washington) and R. Key (Princeton U.).

All LV casts for P17N were done using the starboard A-frame and standard procedures (Key, 1991). Table 1 summarizes the LV sampling and Figure 1 shows the LV station locations.

TABLE 1. LV Sampling Summary

Station	Cast	North Latitude	West Longitude	No. Ger. Samples
10	1	38.234	124.982	9
	3	38.243	124.973	9
28	1	34.602	134.978	9
	3	34.591	134.988	9
39	1	39.613	134.997	9
	3	39.603	135.000	9
48	1	41.666	135.990	9
	3	41.665	136.013	9
58	1	44.959	141.228	9
	3	44.951	141.225	9

68	1	48.214	146.687	9
	3	48.222	146.698	9
78	1	51.478	152.508	9
	3	51.488	152.533	9
86	1	53.981	157.365	9
	3	53.987	157.362	9
132	1	54.835	146.730	9
	3	54.839	146.718	9
141	1	56.215	139.182	9
	3	56.211	139.192	9
7	20	Totals		180

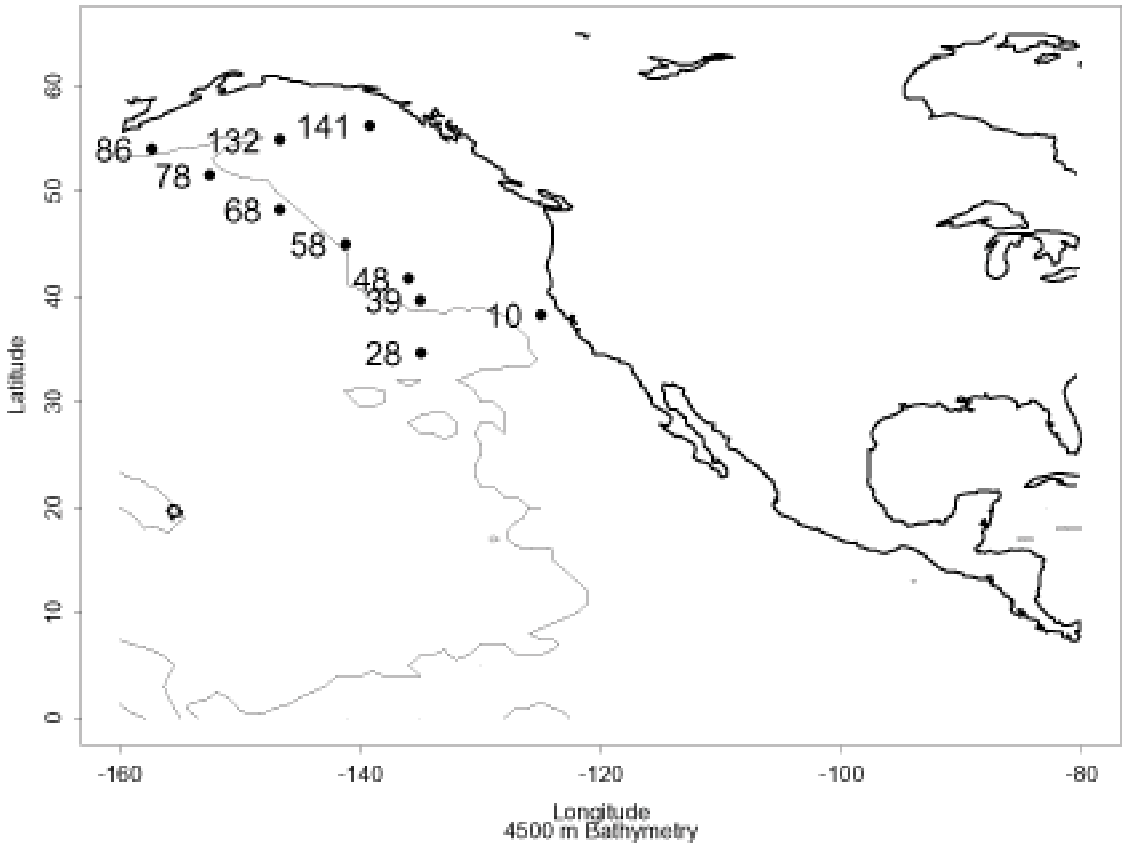

Figure 1: P17N large volume station locations.

Each Gerard barrel was equipped with a piggyback 5 liter Niskin bottle which, in turn, had a full set of high precision reversing thermometers to determine sampling pressure as well as temperature. Both Gerard and Niskin were sampled for salinity and nutrients, but not oxygen. Additionally, each Gerard was sampled for radiocarbon. The salinity and nutrient samples from the piggyback bottle were used for comparison with the Gerard barrel values to verify the integrity of the Gerard sample. As samples were collected, the information was recorded on a sample log sheet. Any abnormalities with sampler or sample collection were also noted. These notes are listed in the appendix. The discrete hydrographic data were entered into the shipboard data system and processed as the analyses were completed. The bottle data were brought to a usable, though not final, state at sea. ODF data checking procedures included verification that the sample was assigned to the correct depth. The salinity and nutrient data were compared by ODF with those from adjacent stations and with the Rosette cast data from the same station. Any comments regarding the water samples were investigated. The raw data computer files were also checked for entry errors.

2.0 Personnel

LV sampling for this cruise was under the direction of the principal investigator, Robert M. Key (Princeton). All LV ^{14}C extractions at sea were done by Rich Rotter (Princeton). Deck work and reading thermometers was done by the SIO CTD group with assistance from many of the scientific party. Salinities and nutrients were analyzed by ODF/SIO personnel. ^{14}C analyses were done at Minze Stuiver's laboratory (U. Washington). Key collected the data from the originators, merged the files, assigned quality control flags to the ^{14}C, rechecked the flags assigned by ODF and submitted the data files to the WOCE office (7/96).

3.0 Results

This data set and any changes or additions supersedes any prior release.

In this data set Gerard samples can be differentiated from Niskin samples by the bottle number. Niskin bottle numbers are in the range 41-49 while Gerards are in the range 81-93.

3.1 Pressure and Temperature

Pressure and temperature for the LV casts are determined by reversing thermometers mounted on the piggyback Niskin bottle. Each bottle was equipped with the standard set of 2 protected and 1 unprotected thermometer. Each temperature value reported on the LV casts was calculated from the average of four readings, provided both protected thermometers functioned normally. The temperatures are based on the International Temperature Scale of 1990. All thermometers, calibrations and calculations were provided by SIO-ODF. Reported temperatures for samples in the thermocline are believed to be accurate to 0.01°C and for deep samples 0.005°C. Pressures were calculated using standard techniques combining wire out with unprotected thermometer data. In cases where the thermometers failed, pressures were estimated by thermometer data from adjacent bottles combined with wire out data. Because of the inherent error in pressure calculations and the finite flushing time required for the Gerard barrels, the assigned pressures have an un-certainty of approximately 10 dB. The pressures recorded in the data set for each Gerard-Niskin pair generally differ by approximately 0.5 dB with the Gerard pressure being the greater. This is because the Niskin is hung near the upper end of the Gerard. Figure 2 shows potential temperature vs. pressure for the LV casts. The agreement between the Gerard and Rosette casts was excellent for almost all data.

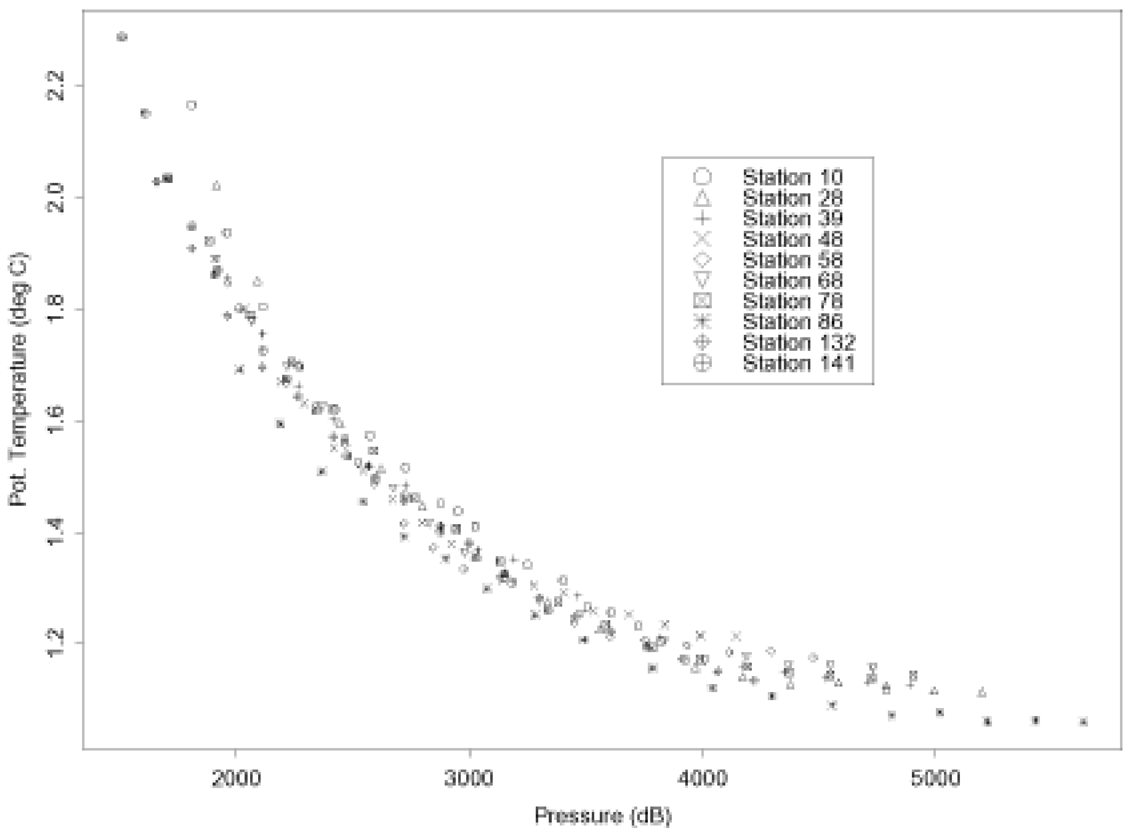

Figure 2: Potential temperature from all Gerard casts.

3.2 Salinity

Salinity samples were collected from each Gerard barrel and each piggyback Niskin bottle. Analyses were performed by the same personnel who ran the salt samples collected from the Rosette bottles so the analytical precision should be the same for LV salts and Rosette salt samples. When both Gerard and Niskin trip properly, the difference between the two salt measurements should be within the range 0.000 - 0.003 on the PSU scale. Somewhat larger differences can occur if the sea state is very calm and the cast is not " yoyo' ed" once the terminal wire out is reached. This difference is due to the flushing time required for the Gerard barrels and the degree of difference is a function of the salinity gradient where the sample was collected. In addition to providing primary hydrographic data for the LV casts, measured salinity values help confirm that the barrels closed at the desired depth. For the area covered by this leg, deep nutrient values (especially silicate) are as useful for trip confirmation as salt measurements due to the very low salt gradients.

Salinity samples were drawn into 200 ml Kimax high alumina borosilicate bottles after 3 rinses, and were sealed with custom-made plastic insert thimbles and Nalgene screw caps. This assembly provides very low container dissolution and sample evaporation. As loose inserts were found, they were replaced to ensure a continued airtight seal. Salinity was determined after a box of samples had equilibrated to laboratory temperature, usually within 8-12 hours of collection. The draw time and equilibration time, as well as per-sample analysis time and temperature were logged.

A single Guildline Autosal Model 8400A salinometer located in a temperature controlled laboratory was used to measure salinities. The salinometer was standardized for each cast with IAPSO Standard Seawater (SSW) Batch P-122, using at least one fresh vial per cast. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 PSU relative to the particular Standard Seawater batch used. PSS-78 salinity (UNESCO 1981) was then calculated for each sample from the measured conductivity ratios, and the results merged with the cruise database. Figure 3 shows potential temperature vs. salinity for the Gerard casts. For comparison the CTD/Rosette data for the same stations and pressure range are plotted as connected small filled squares. In general the agreement between the Gerard-piggyback Niskin pairs is excellent as is agreement between the LV and CTD/Rosette casts.

3.3 Nutrients

Nutrient samples were collected from Gerard casts. LV nutrients were measured along with Rosette nutrients so the analytical precision for Gerard samples should be the same as Rosette samples. Nutrients collected from LV casts are frequently subject to systematic offsets from samples taken from Rosette bottles. For this reason it is recommended that these data be viewed only as a means of checking sample integrity (*i.e.* trip confirmation). The Rosette-Gerard discrepancy is frequently less for silicate than for other nutrients.

Nutrient samples were drawn into 45 ml high density polypropylene, narrow mouth, screw-capped centrifuge tubes which were rinsed three times before filling. Standardizations were performed with solutions prepared aboard ship from pre-weighed chemicals; these solutions were used as working standards before and after each cast to correct for instrumental drift during analysis. Sets of 4-6 different concentrations of shipboard standards were analyzed periodically to determine the linearity of colorimeter response and the resulting correction factors.

Nutrient analyses were performed on an ODF-modified 4 channel Technicon AutoAnalyzer II, generally within one hour of the cast. Occasionally some samples were refrigerated at 2 to 6∞ °C for a maximum of 4 hours. The methods used are described by Gordon *et al.* (1992), Atlas *et al*. (1971), and Hager *et al.* (1972). All peaks were logged manually, and all the runs were re-read to check for possible reading errors.

Silicate was analyzed using the technique of Armstrong *et al.* (1967). ODF'' s methodology is known to be non-linear at high silicate concentrations (>120 µM); a correction for this non-linearity was applied. Phosphate was analyzed using a modification of the Bernhardt and Wilhelms (1967) technique.

Na_2SiF_6, the silicate primary standard, was obtained from Fluka Chemical Company and Fischer Scientific and is reported by the suppliers to be >98% pure. Primary standards for phosphate, KH_2PO_4 , were obtained from Johnson Matthey Chemical Co. and the supplier reports purity of 99.999%.

Nutrients, reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at zero pressure, in-situ salinity, and an assumed laboratory temperature of 25 °C. 258 silicate analyses were performed. No major problems were encountered with the measurements. Figure 4 shows the LV cast silicate values plotted against potential temperature. The Rosette cast measurements from the same stations and depth range are overlain as small filled connected squares. In general the agreement is acceptable, however, the offset for some casts is larger than some other WOCE cruises in the Pacific. The difference between most Gerard - Niskin pairs is less than half the systematic LV - Rosette offset.

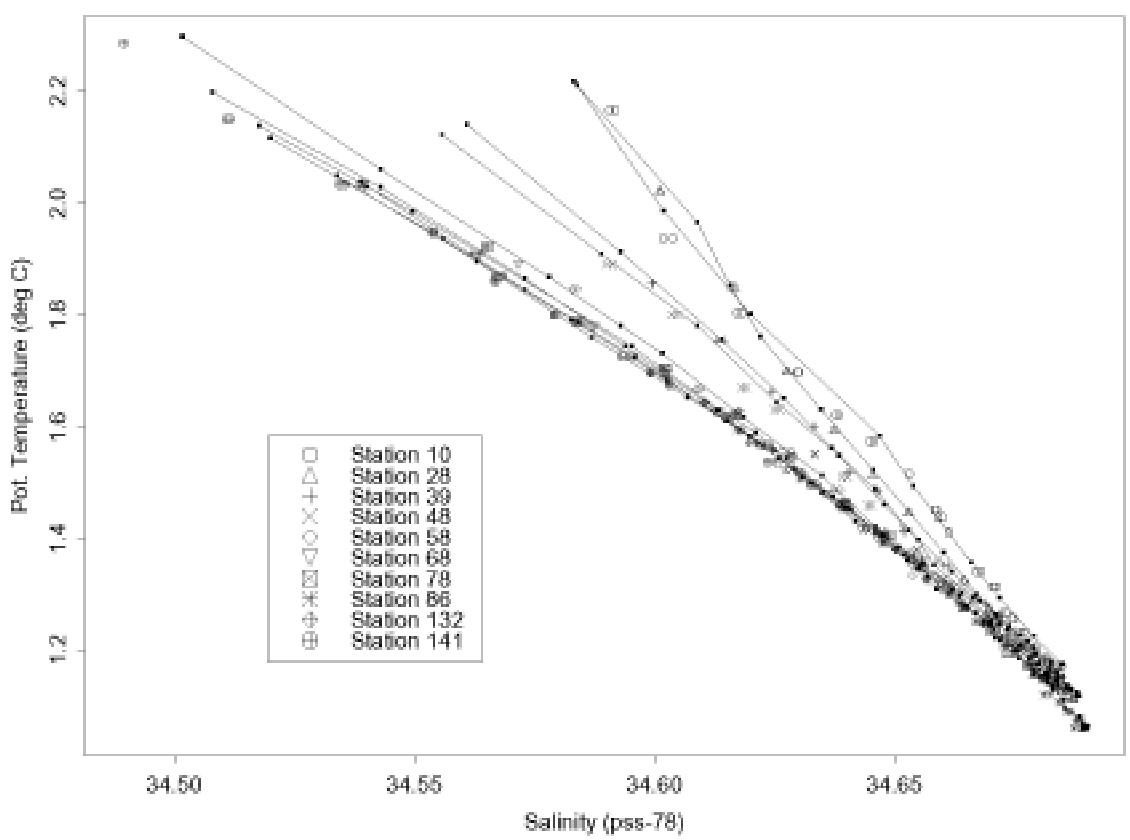

Figure 3: Theta vs. salinity for LV casts. CTD/Rosette data from the same stations and pressure range is overlain as small filled connected squares.

3.4 ^{14}C

All Gerard samples deemed to be " OK" on initial inspection were extracted for ^{14}C analysis using the technique described by Key (1991). The extracted $^{14}CO_2$/NaOH samples were returned to the Ocean Tracer Lab at Princeton and subsequently shipped to Stuiver' s lab in Seattle. Both ^{13}C and ^{14}C measurements are performed on the same CO_2 gas extracted from the large volume samples. The standard for the ^{14}C measurements is the NBS oxalic acid standard for radiocarbon dating. R-value is the ratio between the measured specific activity of the sample CO_2 to that of CO_2 prepared from the standard, the latter number corrected to a $\delta^{13}C$ value of -19‰and age corrected from today to AD1950 all according to the international agreement. $\Delta^{14}C$ is the deviation in ‰ from unity, of the activity ratio, isotope corrected to a sample $\delta^{13}C$ value of -25‰ For further information of these calculations and procedures see Broecker and Olson (1981), Stuiver and Robinson (1974) and Stuiver (1980). Östlund' s lab reports a precision of 4‰for each measurement based on a long term average of counting statistics. Stuiver reports individual errors for each measurement based on counting statistics.

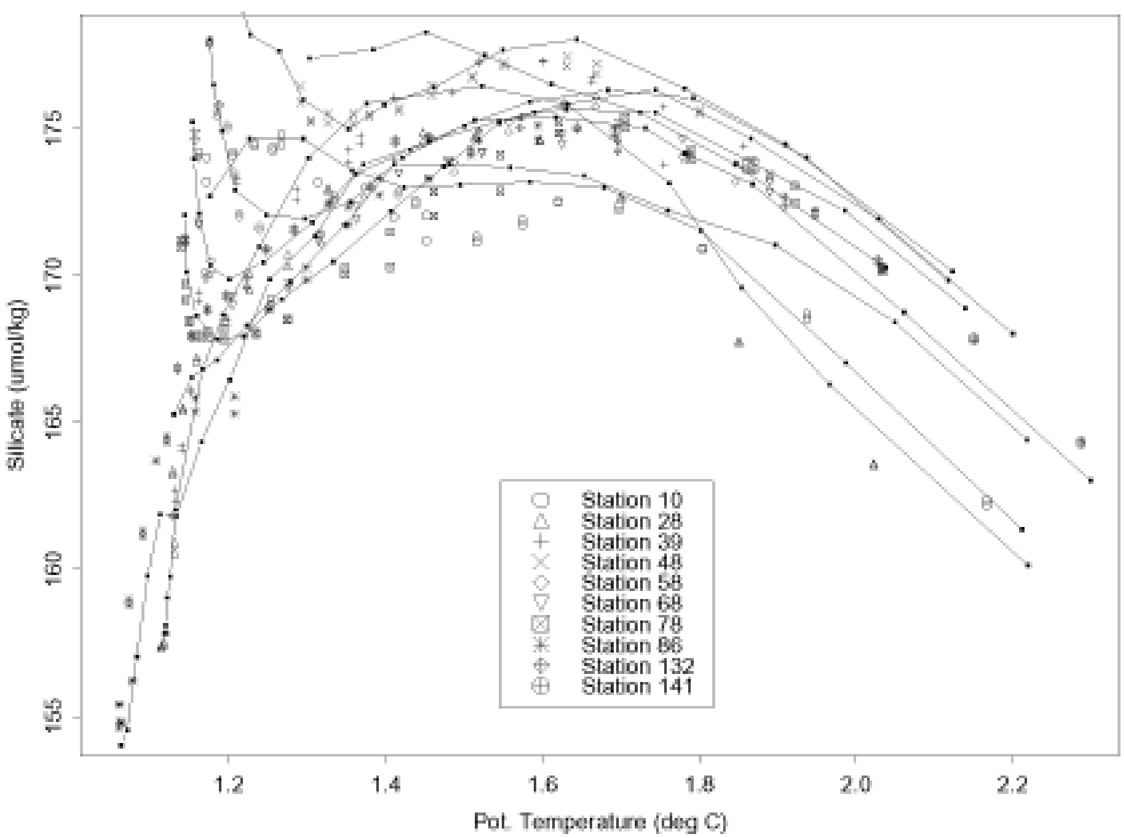

Figure 4: Silicate *vs*. potential temperature for LV casts. Rosette measurements from the same stations and depth ranges are shown as small filled connected squares.

Of the 180 Gerard samples collected, ^{14}C has been reported on 174 (97%). This exceeds the rate funded for this work (80%).

Existing ^{14}C data for the area sampled on this cruise is limited to the LV samples collected along P16N on NOAA cruise CGC-91/2. Comparison of these data sets indicates that they are in agreement to the precision of the measurements.

4.0 Data Summary

Figures 5-7 summarize the large volume ^{14}C data collected on this leg. All $\Delta^{14}C$ measurements with a quality flag value of 2 are included in each figure. Figure 5 shows the $\Delta^{14}C$ values plotted as a function of pressure. One sigma error bars are shown. The most noticeable characteristic is the strong minimum centered at 2500dB for all stations.

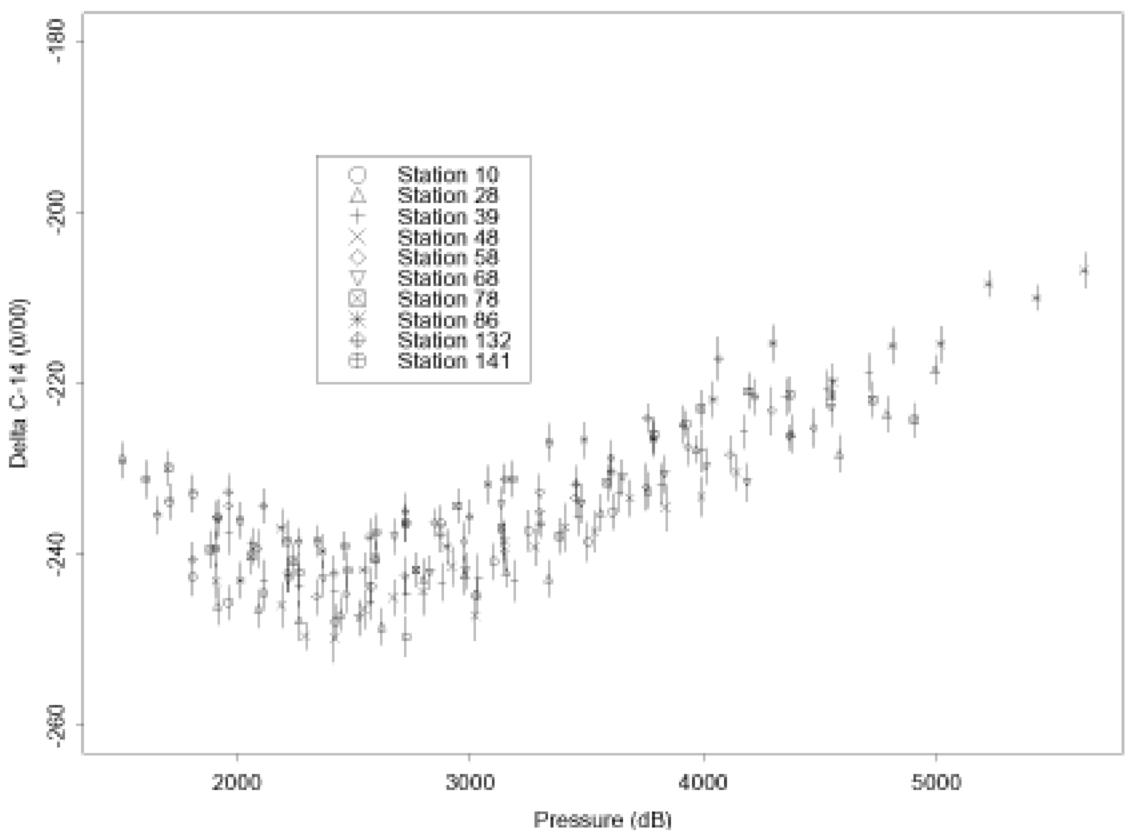

Figure 5: LV Δ ^{14}C vs. pressure for Gerard samples. Vertical bars indicate 1σ standard deviations.

Figure 6 shows $\Delta^{14}C$ values with 1σ error bars plotted against measured Gerard barrel silicate values. This figure differs significantly from similar plots for other cruises.

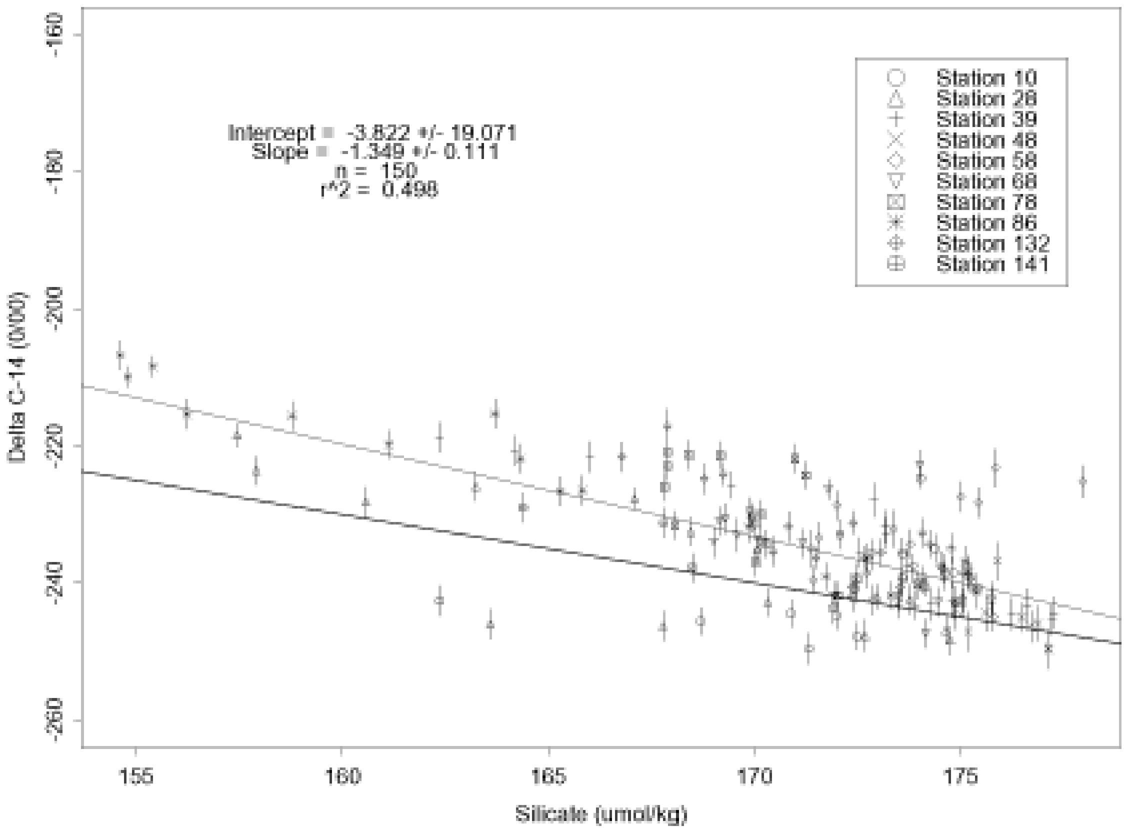

Figure 6: $\Delta^{14}C$ *vs.* silicate for LV samples. The shape of the scatter plot is significantly different than the backwards check mark which is typical of regions further to the south in the Pacific. Additionally, the correlation between the two parameters is uncharacteristically weak. The light straight line is the least squares fit to this data and the heavy line is the relationship suggested by Broecker, *et al.* (1995) to be representative of the global correlation for pre-bomb values.

- The backward check mark shape which is characteristic for most of the Pacific Ocean is totally absent.
- The $\Delta^{14}C$ - silicate correlation, particularly between pressures of 1000dB and the pressure of the silicate maximum, is much weaker than for most of the Pacific, having an R^2 of 0.5 (light line in Figure 6) compared to values generally around 0.9. Additionally the intercept for the least squares line is much higher than previously calculated for other areas (-4‰ compared to ~-60 to -70‰). The least squares line differs significantly in both slope and intercept from the relationship suggested by Broecker, et al. (1995) for the global ocean based on the GEOSECS/TTO/SAVE data sets (heavy line in Figure 6). The sense of that difference is the same, however, as seen with other WOCE Pacific data sets.
- For the same $\Delta^{14}C$ values, the corresponding silicate concentrations are significantly higher than for other regions of the Pacific. This was not unexpected given that the Northeast Pacific is a known strong source region for silicate (Talley and Joyce, 1992)

Figure 7 is a coarse resolution machine contoured section of the ^{14}C distribution in the deep and bottom waters for P17N stations 10, 39, 48, 58, 68, 78 and 86. The minimum at approximately 2500dB increases in intensity to the east and south. This trend was originally defined by the P16N section, but is amplified by this new data. The " youngest" waters are found against the Alaskan slope with the bottom waters being younger than the mid depth waters.

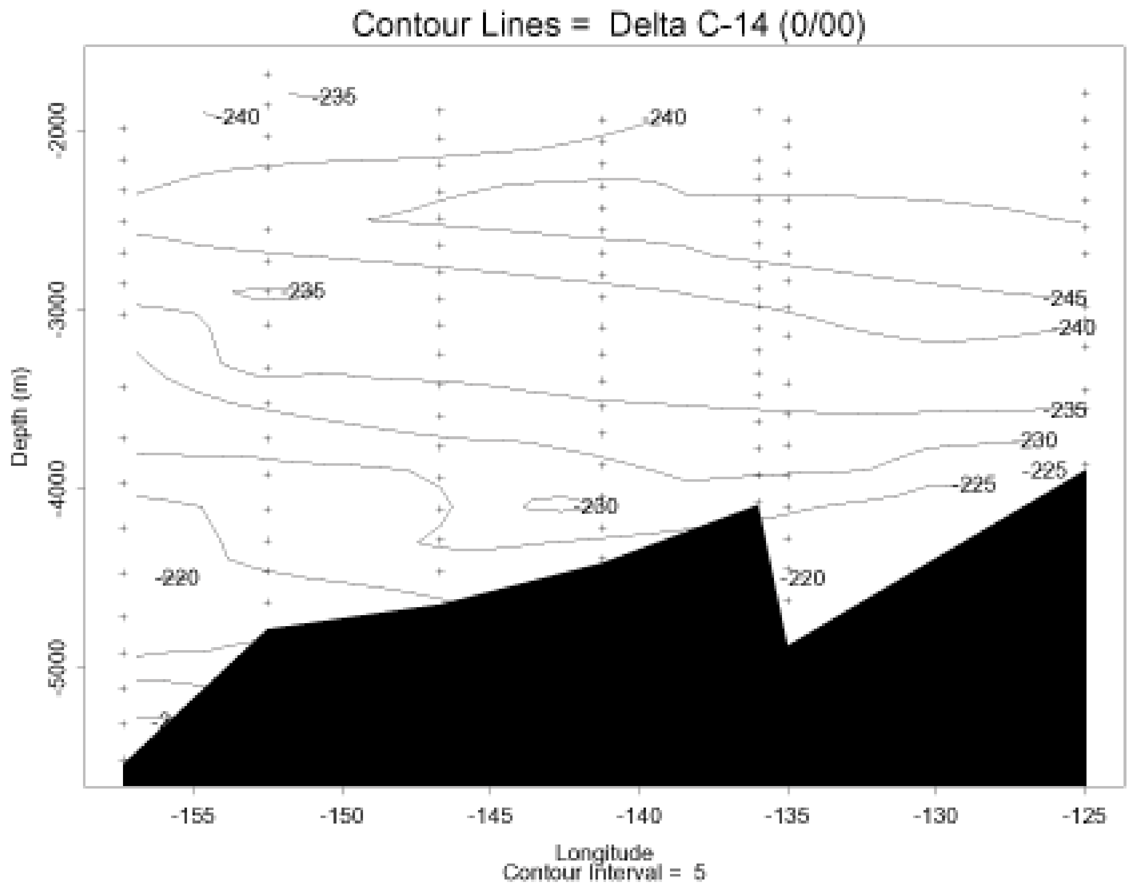

Figure 7: $\Delta^{14}C$ section for LV samples collected along P17N from California (right side) to the Aleutians.

4.1 Quality Control Flag Assignment

Quality flag values were assigned to all bottles and all measurements using the code defined in Tables 0.1 and 0.2 of WHP Office Report WHPO 91-1 Rev. 2 sections 4.5.1 and 4.5.2 respectively. In this report the only bottle flag values used were 2, 3, 4 and 9. For the measurement flags values of 2, 3, 4, 5 or 9 were assigned. The interpretation of measurement flag 9 is unambiguous, however the choice between values 2, 3 or 4 is involves some interpretation. For this data set, the salt and silicate values were checked by plotting them over the same parameters taken from the Rosette at the same station. Points which were clearly outliers were flagged " 4" . Points which were somewhat outside the envelop of the other points were flagged “ 3” . In cases where the entire cast seemed to be shifted to higher or lower concentrations, but the values formed a smooth profile, the data was flagged as “ 2” . All nitrate and phosphate data were flagged “ 4” and were used only to help define other questionable data. Once the silicate and salt data had been flagged, these results were considered in flagging the ^{14}C data. There is very little overlap between this data set and any existing ^{14}C data, so that type of comparison was impractical. In general the lack of other data for comparison led to a more lenient grading on the ^{14}C data.

When using this data set for scientific application, any ^{14}C datum which is flagged with a “ 3” should be carefully considered. My opinion is that any datum flagged “ 4” should be disregarded. When flagging ^{14}C data, the measurement error was taken into consideration. That is, approximately one-third of the ^{14}C measurements are expected to deviate from the true value by more than the measurement precision of ~4‰

No measured values have been removed from this data set. When using this data set, it is advised that the nutrient data (with the exception of silicate) only be considered as a tool for judging the quality of the ^{14}C data. A summary of all flags is provided in Table 2. Note that there may be some errors between assignment of flag value 5 (not reported) and flag value 9 (no sample collected). ODF notes concerning flag assignments are given in the appendix.

TABLE 2. P17N LV Quality Code Summary

	Reported	WHP Quality Codes								
	Levels	1	2	3	4	5	6	7	8	9
BTLNBR	360	0	353	5	0	0	0	0	0	2
SALNTY	358	0	345	11	2	0	0	0	0	2
SILCAT	358	0	320	34	4	0	0	0	0	2
NITRAT	358	0	0	0	358	0	0	0	0	2
NITRIT	322	0	0	0	322	0	0	0	0	2
PHSPHT	358	0	0	0	358	0	0	0	0	2
REVPRS	360	0	360	0	0	0	0	0	0	0
REVTMP	352	0	346	6	0	8	0	0	0	0
DELC14	180	0	166	7	1	6	0	0	0	180

5.0 References and Supporting Documentation

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5.1 Appendix

LVS Quality Comments

Remarks for missing samples, and WOCE codes other than 2 from WOCE P17N Large Volume Samples. Investigation of data may include comparison of bottle salinity and silicate data from piggyback and Gerard with CTD cast data, review of data plots of the station profile and adjoining stations, and rereading of charts (i.e., nutrients). Comments from the Sample Logs and the results of ODF' s investigations are included in this report. Units stated in these comments are micromoles per liter for Silicate unless otherwise noted. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR). PB refers to the bottle that is attached to the Gerard. The comments in normal type are exactly as taken from the ODF data report. Values in *italics* were added by the author and cover changes and additions.

Station 010

142 Sample log: " Not closed. Trip arm missed Push Rod." No samples, no temperature. Gerard (82) appears to be okay.
143 SiO3 appears 2.0 low at 3251db. Calc ok, peak fair, but definitely low. Other water samples ok. Salts agree with rosette. Footnote SiO3 questionable. Gerard (83) appears to be okay. *Silicate flag changed to 4.*
144 SiO3 appears 3.0 low at 3404db. Calc ok, peak fair, but definitely low. Gerard silicate with 44 closer to normal. Footnote SiO3 questionable. Gerard (84) appears to be okay.m *Silicate flag changed to 4*.
181 ^{14}C *high vs. pressure and inconsistent with section, flag 4.*
182 PB 42, Gerard appears to be okay. No temperature.
183 SiO3 appears 3.0 low at 3252db. Calc ok, peak fair, but definitely low. Other water samples ok. Salts agree with rosette. Footnote SiO3 questionable. PB 43, Gerard appears to be okay. *Silicate flag changed to 4.*
184 Note from Stuiver re analysis: Cap swollen, flag 3.

190 *Note from Stuiver re analysis: “Sample Na2CO2 sample” Flag 3.*
347 Gerard (89) leaked, see Gerard comments. NO3 & PO4 are high. PI to decide barrel integrity.
389 Delta PB-Gerard Salinity =.021 at 2727db. Gerard salt looks low compared to other levels this cast and to rosette cast this station. However Gerard nutrients look ok and PB (47) NO3 & PO4 look high? Nutrient sample numbers were incorrectly assigned. After correction, no3 high by 1.4, and PO4 high by.08. SiO3 low by.2, which is within the accuracy of the measurement. Footnote salinity and nutrients all except SiO3 questionable, and bottle leaking. PI to decide barrel integrity. *Salt flag changed to 4.*

Station 028

147 Delta PB-Gerard salt.835 low at 4787db. Nutrients also indicate PB tripped near surface. Term rack ok. Gerard 89 salinity & nutrients look good. Delta-S PB-Gerard at 4787db is -0.835, salinity is 33.851. Footnote bottle leaking, samples bad. Gerard (89) is okay.
183 Sample Log: “ Air leak. Loose fitting at bottom.” Delta PB- Ger salt 0.0001. Nutrients also match well. PB 43. Gerard is okay.
193 Sample Log: “ Very slight air leak.” Delta PB-Ger salt 0.0005. Nutrients also match well. PB 49. Gerard is okay. *C-14 low vs. pressure and inconsistent with section, flag 3.*
347 PB failed to trip. Trip rod not down far enough to release lanyards. Gerard 89 salt & nutrients look good. No samples, no temperature. Gerard is okay.
382 Sample Log: “ Top valve loose.” Delta PB-Ger salt 0.0008. Nutrients also match well. PB 42. Gerard is okay.
383 Sample Log: “ Significant air leak.” Delta PB-Ger salt 0.0002. Nutrients also match well. PB 43. Gerard is okay.
389 No temperature see PB 47 comment. Gerard is okay.
393 Sample Log: “ Slow air leak” . Delta PB-Ger salt 0.0005. Nutrients also match well. PB 49. Gerard is okay.

Station 039

141 Gerard (81) is reasonable, PI may want to double-check. Delta-S PB-Gerard at 3464db is 0.0031, salinity is 34.669. See 181 comments Gerard is questionable. Gerard (81).
142 Temp. appears 0.03 high. PB water samples agree with rosette. PB water samples appear deeper than Gerards, while temp is shallower. Apparent rack posttrip. NO3 is 0.2 high, which is within the specs of the measurement. Delta-S PB-Gerard at 3641db is 0.0065, salinity is 34.673. See 182 comments, Gerard (82), footnote temperature questionable.
144 Temp appears 0.03 high. PB water samples agree with rosette. Footnote temperature questionable. Gerard (84) is okay.
181 Sample log: “ Air Vent open.” Delta PB-Ger salt = 0.003 at 3464db. Calc & Autosal runs ok. NO3 same, PO4 indicates Gerard has shallower water but

most PO4 comparisons have higher Gerard values than B.S. Suspect bottle okay, salinity difference is not that unreasonable. PI will have to make final determination on this sample. PB 41.

182 Sample log: " ger vent open." Delta PB-Ger salt = 0.0065 at 3641db. Salinity calc & Autosal runs ok. Nutrient differences inconclusive. Footnote bottle leaking, salinity and temperature questionable. See PB 142 temperature comment. PI will have to make final determination on this sample. PB (42).

183 Sample log: " Air leak." Delta PB-Ger salt 0.0016 at 3818db. Salinity calc & Autosal runs ok. Nutrients reasonable. PB (43).

184 Delta PB-Ger salt 0.0006 at 3996db. Nutrients reasonable. Footnote temperature questionable, see PB 144 temperature comment.

341 Gerard (93) is okay.

387 Sample log: " Slow air leak." Delta PB-Ger salt = 0.0004 at 2727db. Nutrients also ok. PB 44. Gerard is okay.

393 Sample log: " Slow air leak." Delta PB-Ger salt = 0.0006 at 3294db. Nutrients also ok. PB 41. Gerard is okay.

Station 048

141 Delta-S PB-Gerard at 3024db is 0.003, salinity is 34.659. Gerard (81) indicates a slight leak.

142 Sample log: " Slight air leak. Re-seated top, ok" Gerard (82).

145 Delta-S PB-Gerard at 3534db is 0.002, salinity is 34.670. See Gerard (85) SiO3 comment. Footnote SiO3 questionable.

146 Footnote SiO3 questionable. See 185 comments. Gerard (87) is okay.

147 Sample log: " Light air leak. Re-seated top, ok." Delta PB- Ger salt =0.001 at 3838db. Nutrients also look ok. Gerard (89) is okay. Footnote SiO3 questionable. See 185 comments.

148 Gerard (90) is okay. Footnote SiO3 questionable. See 185 comments.

149 Footnote SiO3 questionable. See 185 comments. Gerard (93) is okay.

181 Sample log: " Air vent loose. Went down tight per DM & RR." Delta PB-Ger 0.003 at 3024db. Nutrients look reasonably close. Very slight sample leak if any. Footnote Gerard leaking, but data acceptable, let PI make final decision. PB 41.

182 Sample log: " Air vent just barely tight. No air leak." Delta PB-Ger 0.001 at 3151db. Nutrients also ok. PB 42.

185 Sample log: " Air vent slightly loose. V. slow air leak." Delta PB-Ger salt 0.002 at 3534db. PO4 & SIL also indicate very slight leak. PB 45. Gerard is probably okay, but PI should double check. Footnote bottle leaking. SIL is ~-0.2 low compared to rosette cast, do not suspect a problem with the Gerard barrel, but rather the SiO3 analysis. From this sample to the deepest there appears to be a ~-0.2 offset. Footnote SiO3 questionable.

187 Sample log: " Air vent slightly loose. V. slow air leak." Delta PB-Ger salt.001 at 3686db. Nutrients also look ok. PB 46. Footnote SiO3 questionable. See 185 comments.

189 Footnote SiO3 questionable. See 185 comments. PB 47.

190 Footnote SiO3 questionable. See 185 comments. PB 48.

193 Sample log: " V. slow air leak." Delta PB-Ger salt 0.001 at 4144db. Nutrients also look ok, taking into account SiO3 problem. PB 49. Footnote SiO3 questionable. See 185 comments.

Cast 3 PB sample numbers for salinity were not filled in. Wrote in numbers 1-9. Salinities appear to be okay. Nitrites not run this station since only 3 colorimeters functioning. Footnote NO2 lost.

341 PO4 appears 0.04 low at 1911db compared to Gerard and rosette profile. Calc & peak ok. Used 2nd of 2 samples from 41 to account for large jump from SSW to deep nutrient values. Other nutrients and salt ok. PO4 is questionable. Gerard (81) is okay.

385 Sample log: " Slight air leak." Delta PB-Ger Salt 0.0002 at 2420db. Nutrients also have good agreement. Gerard is okay. PB 45.

390 Delta PB-Ger salt 0.004 at 2800db. Calc & autosal runs ok. Excellent agreement between nutrients. PB salt matches rosette salt better than Gerard salt. Footnote salinity questionable. Gerard is okay. PB 48.

393 Sample log: " Air leak." Delta PB-Ger salt 0.0004 at 2924db. Nutrients also have good agreement. Gerard is okay. PB 49.

Station 058

141 Sample log: " Air leak, re-seated top, ok." Delta PB-Ger salt 0.001 at 3148db. Nutrients from PB also okay, although Gerard PO4 is 0.04 high. Gerard (81) is okay.

142 DSRT rack reversed late, no temperature. Thin lanyard pulled into release pin hole. Replaced rack lanyard after this station. Gerard (82) is okay.

181 PO4 0.04 high at 3148db compared to rest of Gerard PO4 profile and about 0.02 high compared to rosette profile this level. Delta PB-Ger salt 0.001 and other nutrients ok. PB 41.

182 No temperature see PB 42 comment. Gerard is okay.

342 DSRT rack reversed late, no temperature. Thin lanyard pulled into release pin hole. Replaced rack lanyard after this station. Gerard (82) is okay.

382 No temperature, see PB 42 comment, Gerard is okay.

383 Sample log: " Air leak." Delta PB-Ger salt 0.0007 at 2217db. Nutrients also ok. PB 43, gerard is okay.

384 Sample log: " Slow air leak." Delta PB-Ger 0.0003 at 2342db. Nutrients also ok. PB 44, Gerard is okay.

385 Sample log: " Slow air leak." Delta PB-Ger 0.0003 at 2468db. Nutrients also ok. PB 45, Gerard is okay.

393 Sample log: " Slow airleak." Delta PB-Ger salinity = 0.005 at 2975db. Calc & Autosal runs ok. Nutrients all agree well. PB salt higher and Gerard salt lower than rosette salinity this level. PB 49, Gerard is probably okay, let PI decide.

Station 068

141 Delta PB-G S=.003. Calc & Autosal runs ok. PB slightly higher & Ger slightly

lower than rosette trace. Nitrates & silicates agree. Ger PO4 a little high as usual. Footnote salinity questionable. Suspect Gerard (81) is okay.

143 Temperature low by 0.02 flag 3 also for accompanying Gerard.

146 Delta PB-G S=.004 at 4188db. Calc & Autosal runs ok. Gerard salt appears low compared to other samples & rosette trace. Nutrients agree reasonably well. Gerard (87) is okay.

149 Delta PB-G S=.003 at 4730db. Calc & Autosal runs ok. Gerard salt appears low compared to other samples & rosette trace. Nutrients agree reasonably well. Suspect Gerard (93) is okay.

181 Delta PB-G S=.003. Calc & Autosal runs ok. PB slightly higher & Ger slightly lower than rosette trace. Nitrates & silicates agree. Ger PO4 a little high as usual. Footnote salinity questionable. Suspect Gerard is okay, PB 41.

187 Delta PB-G S=.004 at 4188db. Calc & Autosal runs ok. Gerard salt appears low compared to other samples & rosette trace. Nutrients agree reasonably well. Footnote salinity questionable, not within specification of measurement. PB 46, Gerard is okay.

193 Delta PB-G S=.003 at 4730db. Calc & Autosal runs ok. Gerard salt appears low compared to other samples & rosette trace. Nutrients agree reasonably well. Footnote salinity questionable. Suspect Gerard is okay, PB 49. *C-14 low vs. pressure and Si, flag 3.*

341 Delta PB-Ger Salt difference -.005. Ger S fits profile & rosette. PB seems low. Footnote salinity questionable. Gerard (81) is okay.

343 Delta-S PB-Gerard at 2220db is -0.0021, salinity is 34.599. Gerard (83) is okay.

381 Delta PB-Ger Salt diff -.005. Ger S fits profile & rosette. PB seem low. Nutrients have good agreement between Ger & PB. PB 41, Gerard is okay.

383 Sample log: " Air leak." Delta PB-Ger S =-.002. Gerard salt matches profile & rosette salts better than PB. Nutrients have good agreement between Ger & PB. Gerard is okay, PB 43.

385 Sample log: " Slow air leak." Delta PB-G S=-.001. Nutrients also agree. PB 45.

387 Sample log: " Slow air leak." Delta PB-G S=.001. Nutrients also agree. PB 46.

393 Sample log: " Slow air leak." Delta PB-G S =.000. Nutrients also agree. PB 49.

Station 078

185 Sample log: " Slow air leak." Delta PB-Ger Salt = 0.0001 at 4192db. NO3 & SIL also ok. Gerard PO4 0.04 high but Gerard PO4s are usually high. Gerard sample looks ok. PB 45.

187 Sample log: " Slow air leak." Delta PB-Ger Salt = 0.0009 at 4370db. Nutrients also ok. PB 46.

193 Sample log: " Slow air leak." Delta PB-Ger Salt = -.0009 at 4903db. Nutrients also ok. PB 49.

385 Sample log: " Slow air leak." Delta PB-Ger Salt = 0.0007 at 2415db. NO3 & Sil also ok. Gerard PO4 0.03 high but Gerard PO4s are usually high. Gerard sample looks ok. PB 45. High vs. P, flag 3.

387 Sample log: " Slow air leak." Delta PB-Ger Salt = 0.0003 at 2592db. Gerard

nutrients also ok. PB NO3 & SIL a little low this level (346) PB 46.

393 Sample log: “ Slow air leak.” Delta PB-Ger Salt = 0.0005 at 3133db. Nutrients also ok. PB 49.

Station 086

Cast 1 PB sample numbers for nuts and salinity were not filled in. Wrote in numbers 1-9. Samples appear to be okay.

145 Delta-S(PB-g) at 4812db is 0.0027, salinity is 34.688. Suspect Gerard (85) is okay.

148 PO4 0.08 high at 5428db. Calc & peak ok. Delta PB-Ger salt = -.0004, other nutrients and Gerard PO4 ok. Assume PO4 contamination PB 48. Gerard (90) is okay.

183 Sample log: “ Slow air leak.” Delta PB-Ger Salt = 0.0009 at 4299db. Nutrients also ok. PB 43.

185 Sample log: “ Major air leak.” Delta PB-Ger Salt = 0.0027 at 4812db. Gerard salt looks low compared to other salts this station. However, nutrients have reasonably good agreement this level. Footnote salinity questionable. Suspect Gerard is okay, PB 45.

187 Sample log: “ Slow air leak.” Delta PB-Ger Salt = 0.0005 at 5018db. Nutrients also ok. PB 46.

346 Suspect Gerard (87) is okay. Delta-S PB-Gerard at 2900db is 0.0023, salinity is 34.655. Footnote salinity questionable.

385 Sample log: “ Slow air leak.” Delta PB-Ger Salt = 0.0005 at 2722db. Nutrients also ok. PB 45.

387 Sample log: “ Slow air leak.” Delta PB-Ger Salt = 0.0023 at 2900db. Nutrients look ok. Difficult to tell which salt looks better because of gradient. Footnote salinity questionable. Suspect Gerard is okay, PB 46.

Station 132

146 Delta-S PB-Gerard at 3759db is 0.002, salinity is 34.677. Footnote salinity questionable. Gerard (87) is acceptable.

147 PO4 0.08 high at 3912db. Peak ok. Delta PB-Ger salt 0.001 and other nutrients ok. Gerard PO4 looks good. Assume PO4 contamination in PB 47. Gerard (89) is acceptable.

347 Sample log: “ Air leak, re-seated top, ok.” Delta PB-Ger salt 0.001 at 2569db. Nutrients also ok. Gerard (89) is acceptable.

389 PB 47. Gerard samples are acceptable.

Station 141

Cast 1 Silicate has a problem, other water properties ok. All silicate values about 2.0 lower than rosette silicates. Nothing obvious in data. AA controller did not sample third end SW but final SW adjusted based on difference between 2nd & 3rd SW on adjacent station.

141 All silicate values about 2.0 lower than rosette silicates. Footnote SiO3 questionable. See Cast 1 SiO3 comment. Gerard (81) is acceptable.
142 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (82) is acceptable.
143 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (83) is acceptable.
144 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (84) is acceptable.
145 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (85) is acceptable.
146 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (87) is acceptable.
147 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (89) is acceptable.
148 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Gerard (90) is acceptable.
149 See Cast 1 SiO3 comment. Footnote SiO3 questionable. Delta- S PB-Gerard at 3338db is 0.002, salinity is 34.672. Gerard (93) is acceptable.
181 See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 41, Gerard is okay.
182 Sample log: " Major air leak." Delta PB-Ger salt 0.002 at 2466db. Calc & Autosal run ok. Gerard salt appears slightly low. Nutrients agree well. See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 42. Gerard is acceptable.
183 See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 43, Gerard is okay.
184 See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 44, Gerard is okay.
185 Sample log: " Slight air leak." Delta PB-Ger salt 0.001 at 2724db. Calc & Autosal run ok. Nutrient agreement also reasonable. See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 45. Gerard is acceptable.
187 Sample log: " Moderate air leak." Delta PB-Ger salt 0.0014 at 2876db. Calc & Autosal run ok. Nutrient agreement also reasonable. See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 46. Gerard is acceptable.
189 See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 47, Gerard is okay. *Note from Stuiver re analysis: "Leaky cap", flag C-14 as 3.*
190 See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 48, Gerard is okay.
193 See Cast 1 SiO3 comments. Footnote SiO3 questionable. PB 49, Gerard is okay.
Cast 3 Deeper silicate values up to 1.0 higher than rosette sil. See Cast 1 nutrient comments.
347 Deeper silicate values up to 1.0 higher than rosette sil. See Cast 3 SiO3 comment. Footnote SiO3 questionable. Gerard (89) is okay.
348 See Cast 3 SiO3 comment. Footnote SiO3 questionable. Gerard (90) is acceptable.

349 See Cast 3 SiO3 comment. Footnote SiO3 questionable. Gerard (93) is acceptable.

389 See Cast 3 SiO3 comment. Footnote SiO3 questionable. PB 47, Gerard is okay.

390 See Cast 3 SiO3 comment. Footnote SiO3 questionable. PB 48, Gerard is okay.

393 See Cast 3 SiO3 comment. Footnote SiO3 questionable. PB 49, Gerard is okay.

P17N
Final Report
for AMS ^{14}C Samples

Robert M. Key & Paul D. Quay
February 18, 1998

1.0 General Information

WOCE cruise P17N was carried out aboard the R/V Thomas G. Thompson in the north-eastern Pacific Ocean. The WHPO designation for this cruise was 325021/1. David L. Musgrave was the chief scientist. The cruise departed San Francisco, CA on May 15, 1993 and ended on June 26, 1993 at Sitka, AK. The cruise made a NE to SW section from San Francisco to approximately 35°N x 135°W. From there the track went north to approximately 41°N then angled north-westward to Dutch Harbor, AK. The final portion of the track went from approximately 53°N x 155°W trending north-northeast toward Sitka, AK. The reader is referred to cruise documentation provided by the chief scientists as the primary source for cruise information. This report covers details of the small volume radiocarbon samples. The AMS station locations are summarized in Table 1 and shown in Figure 1. A total of 539 AMS $\Delta^{14}C$ samples were collected at 23 stations. In addition to the AMS samples, large volume Gerard samples were also collected on this cruise.

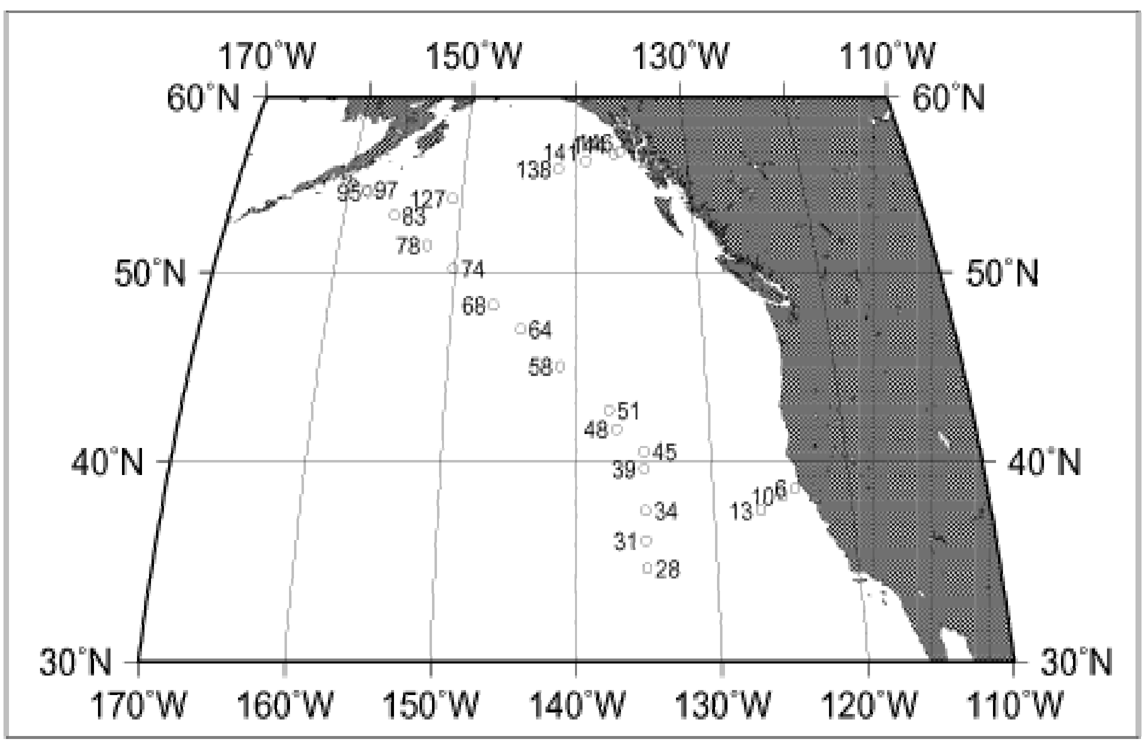

Figure 1: AMS ^{14}C station locations for WOCE P17N (map by GMT, Wessel and Smith, 1991,1995).

TABLE 1. AMS Station Locations

Station	Date	Latitude	Longitude	Bottom Depth (m)	Max. Sample Pressure	Sample Extraction
6	16/5/93	38.627	-124.061	2534	2566	NOSAMS
10	18/5/93	38.230	-124.981	3872	3948	NOSAMS
13	18/5/93	37.504	-126.643	4520	4601	U. Wash.
28	23/5/93	34.585	-135.000	5192	5301	U. Wash.
31	24/5/93	36.000	-135.001	5121	5204	U. Wash.
34	24/5/93	37.499	-135.010	5244	5357	U. Wash.
39	26/5/93	39.618	-135.002	4738	4837	NOSAMS
45	27/5/93	40.503	-135.003	4241	4326	U. Wash.
48	28/5/93	41.653	-136.999	3992	4051	NOSAMS
51	29/5/93	42.637	-137.528	4160	4207	U. Wash.
58	31/5/93	44.956	-141.234	4413	4488	U. Wash.
64	2/6/93	46.897	-144.429	4677	4765	U. Wash.
68	3/6/93	48.214	-146.688	4662	4748	U. Wash.
74	6/6/93	50.179	-150.155	4679	4769	U. Wash.
78	8/6/93	51.491	-152.543	4622	4722	U. Wash.
83	9/6/93	53.130	-155.633	4499	4579	U. Wash.
95	13/6/93	54.488	-158.298	1857	1887	NOSAMS
97	13/6/93	54.567	-158.442	1063	1085	NOSAMS
127	16/6/93	54.060	-150.818	4445	4383	U. Wash.
138	19/6/93	55.781	-141.616	3254	3320	U. Wash.
141	20/6/93	56.216	-139.167	3327	3367	NOSAMS
144	21/6/93	56.677	-136.593	2091	2091	U. Wash.
146	21/6/93	56.778	-136.037	1057	1052	NOSAMS

The large volume results were reported previously by Key, 1996(b).

2.0 Personnel

^{14}C sampling for this cruise was carried out by R. Rotter from the Ocean Tracer Lab at Princeton University and R. Sonnerup from the Univ. of Washington. Sample extraction and $\delta^{13}C$ analyses were performed by either NOSAMS (National Ocean Sciences AMS Facility at Woods Hole Oceanographic Institution) or P. Quay's group at the U. Washington as indicated in the last column of Table 1. ^{14}C analyses were performed at NOSAMS. Salinity, oxygen and nutrients were analyzed by Scripps ODF. R. Key collected the data from the originators, merged the files, assigned quality control flags to the ^{14}C results and submitted the data files to the WOCE office (2/98). R. Key and P. Quay are the PIs for the ^{14}C data.

3.0 Results

This ^{14}C data set and any changes or additions supersedes any prior release. The $\Delta^{14}C$ results reported here are, under WOCE guidelines, considered proprietary for two years after publication of the preliminary data report (Dec. 1999) or until publication, whichever comes first.

3.1 Hydrography

Hydrography from this leg has been submitted to the WOCE office by the chief scientist and described in the hydrographic report which is available via the web address (http://diu.cms.udel.edu/woce/data/reports/pacific/p17_n_93_musgrave.sum).

3.2 ^{14}C

The $\Delta^{14}C$ values reported here were originally distributed in a data report (NOSAMS, December 31, 1997). That report included preliminary results which had not been through the WOCE quality control procedures.

All of the AMS samples from this cruise have been measured. Replicate measurements were made on 13 water samples. These replicate analyses are tabulated in Table 2. The table shows the error weighted mean and uncertainty for each set of replicates. Uncertainty is defined here as the larger of the standard deviation and the error weighted standard deviation of the mean. For these replicates, the simple average of the normal standard deviations for the replicates is 3.9‰ (equal weighting for each replicate set). This precision is typical for the time frame over which these samples were measured (Jul. 1995 - Dec. 1997). Note that the errors given for individual measurements in the final data report (with the exception of the replicates) include only counting errors, and errors due to blanks and backgrounds. The uncertainty obtained for replicate analyses is an estimate of the true error which includes errors due to sample collection, sample degassing, etc. For a detailed discussion of this see Key (1996).

TABLE 2. Summary of Replicate Analyses

Sta-Cast-Bottle	$\Delta^{14}C$	Err	E.W.Mean [a]	Uncertainty [b]
6-1-14	21.81	3.18	24.18	4.48
	28.15	4.12		
31-1-1	27.14	6.36	35.76	15.34
	48.83	7.83		
45-1-15	-89.58	3.29	-90.29	2.44
	-91.16	3.65		
68-2-19	-190.39	4.62	-191.54	2.76
	-192.18	3.44		
83-1-8	-87.46	3.02	-91.50	5.03
	-94.58	2.64		
95-1-14	29.49	4.79	30.01	2.84
	30.29	3.53		
95-1-16	-14.12	3.05	-15.60	2.54
	-17.72	3.64		

127-1-2	21.65	3.75	25.43	3.93
	27.21	2.57		
127-1-20	-213.18	2.81	-214.03	2.03
	-214.95	2.93		
138-1-17	-134.76	3.27	-134.85	2.26
	-134.92	3.12		
138-1-28	-241.60	2.91	-245.72	8.41
	-253.49	4.00		
141-2-29	-229.80	3.03	-230.57	1.85
	-231.02	2.33		
146-1-34	-162.13	3.46	-167.64	2.10
	-170.84	2.64		

a. Error weighted mean reported with data set
b. Larger of the standard deviation and the error weighted standard deviation of the mean.

A check on the long term reproducibility of the measurements is possible by comparing data from this cruise with 2 previous WOCE cruises in the same area. Figure 2 A compares data from P17N with the NOAA test cruise CGC91/1 (Key, et al., 1996). The comparison is for the section along 135°W between 34° and 42°N. Figure 2 B compares data from P17N with P16N. The comparison is for data bounded by the box 48°-55°N and 153°-151°W (Key, *et al*., 1996). For the data shown, the comparison is very good. The only apparent difference is very near the surface where real seasonal differences in either $\Delta^{14}C$ concentration or water structure could cause the offset. In each figure the measurements are shown with 2σ error bars.

4.0 Quality Control Flag Assignment

Quality flag values were assigned to all $\Delta^{14}C$ measurements using the code defined in Table 0.2 of WHP Office Report WHPO 91-1 Rev. 2 section 4.5.2. (Joyce, et al., 1994). Measurement flags values of 2, 3, 4, 5 and 6 have been assigned. The choice between values 2 (good), 3 (questionable) or 4 (bad) involves some interpretation.

When using this data set for scientific application, any ^{14}C datum which is flagged with a “3” should be carefully considered. My subjective opinion is that any datum flagged “4” should be disregarded. When flagging ^{14}C data, the measurement error was taken into consideration. That is, approximately one-third of the ^{14}C measurements are expected to deviate from the true value by more than the measurement precision (~3.9‰). No measured values have been removed from this data set, therefore a flag value of 5 implies that the sample was totally lost somewhere between collection and analysis. Table 3 summarizes the quality control flags assigned to this data set. For a detailed description of the flagging procedure see Key, *et al*. (1996).

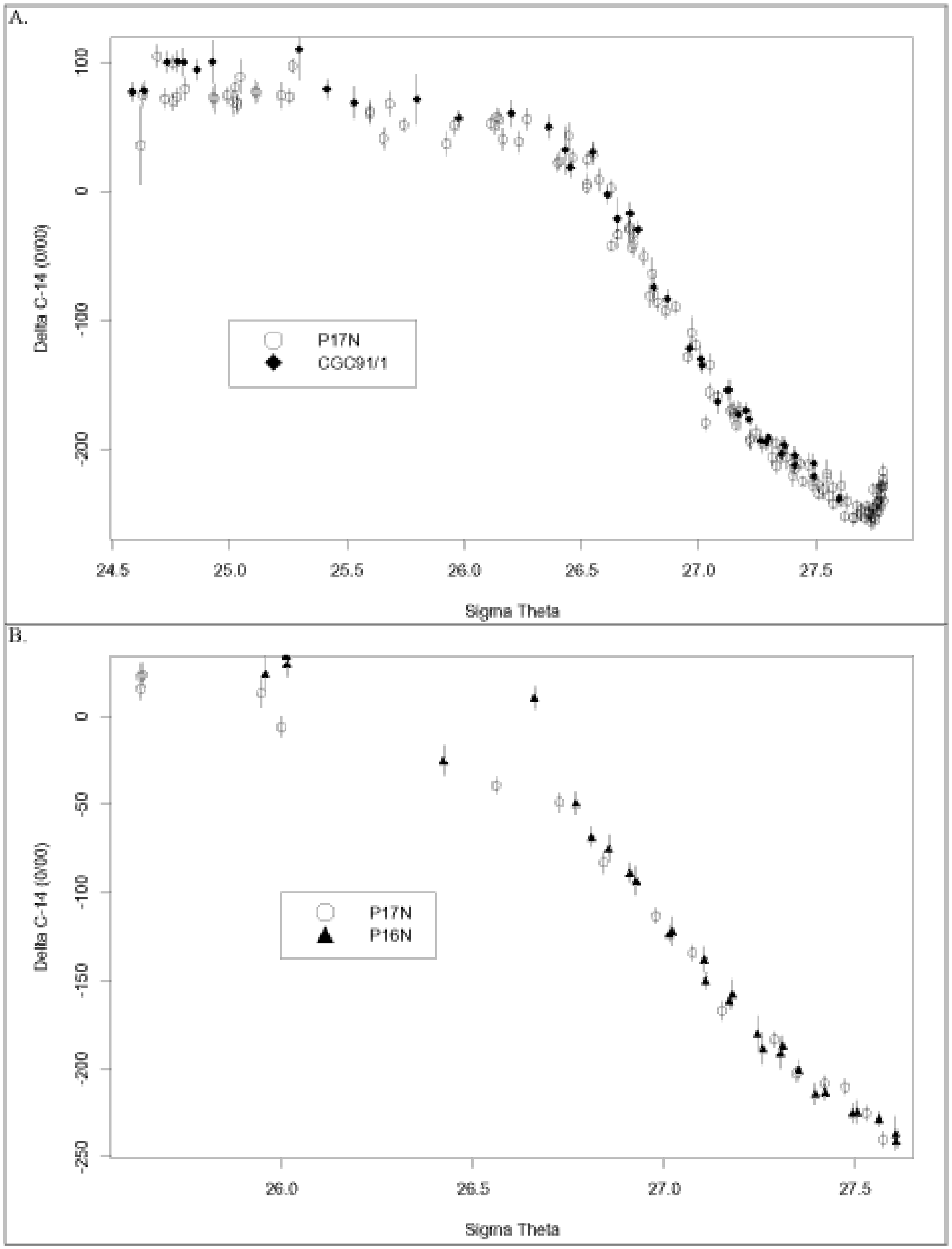

Figure 2: Data comparison for overlap regions of the cruises indicated. Data are shown with 2σ error bars. Other than very near the surface where real seasonal differences may exist, the data appear to agree to within the estimated uncertainty.

TABLE 3. Summary of Assigned Quality Control Flags

Flag	Number
2	504
3	7
4	1
5	14
6	13

5.0 Data Summary

Figures 3-10 summarize the $\Delta^{14}C$ data collected on this leg. Only $\Delta^{14}C$ measurements with a quality flag value of 2 ("good") or 6 ("replicate") are included in each figure. Figure 3 shows the $\Delta^{14}C$ values with 2σ error bars plotted as a function of pressure. The mid depth $\Delta^{14}C$ minimum which normally occurs around 2200 to 2400 meters in the Pacific is very weak in this data set primarily because the deep and bottom water values are low relative to the rest of the Pacific.

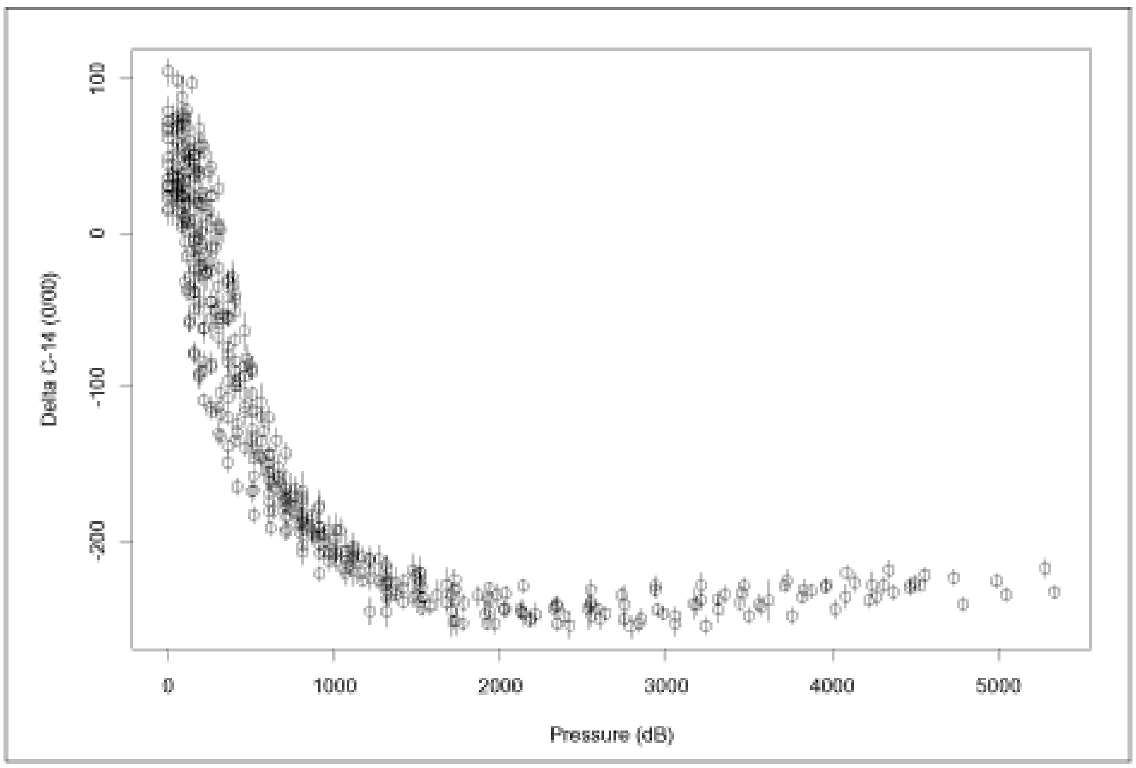

Figure 3: $\Delta^{14}C$ results for P17N stations shown with 2σ error bars. Only those measurements having a quality control flag value of 2 or 6 are plotted.

Figure 4 shows the $\Delta^{14}C$ values plotted against silicate. The straight line shown in the figure is the least squares regression relationship derived by Broecker *et al*. (1995) based on the GEOSECS global data set. According to their analysis, this line ($\Delta^{14}C$ = -70 - Si) represents the relationship between naturally occurring radiocarbon and silicate for most of the ocean. They interpret deviations in $\Delta^{14}C$

above this line to be due to input of bomb-produced radiocarbon, however, they note that the interpretation can be problematic at high latitudes. Samples collected from shallower depths at these stations show an upward trend with decreasing silicate values reflecting the addition of bomb produced ^{14}C. The $\Delta^{14}C$ values for the silicate concentration range 0-120 µmol/kg fall above Broecker's global pre-bomb trend. With most of the Pacific data sets, the silicate - $\Delta^{14}C$ trend doubles back on itself with the deep and bottom water values having a somewhat steeper slope than the waters from the thermocline (down to approximately 2500m). This doubling back is absent from the P17N data (Key, 1996b). Even more unusual is the fact that $\Delta^{14}C$ trend for shallow and thermocline waters is approximately straight. Except for the southern ocean, all other regions of the Pacific have a $\Delta^{14}C$ - silicate trend in the upper water column which markedly curves upward. The reason for the unusual shape is currently under investigation.

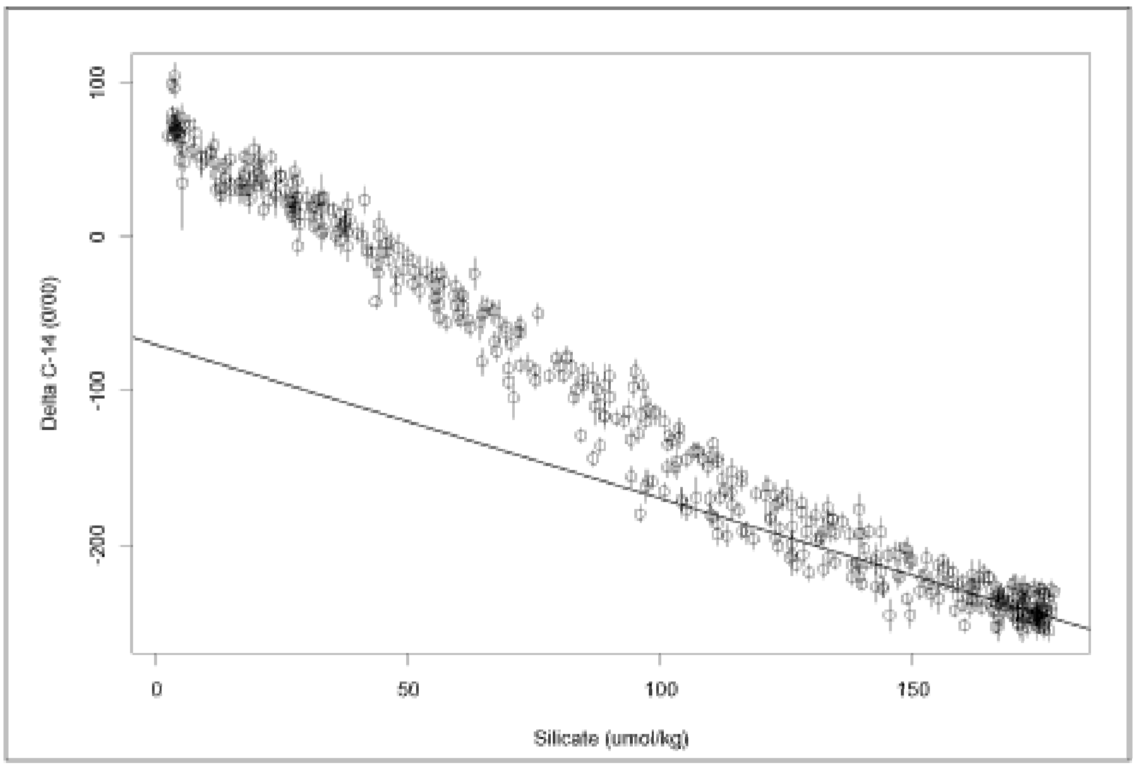

Figure 4: $\Delta^{14}C$ as a function of silicate for P17N AMS samples. The straight line shows the relationship proposed by Broecker, *et al*., 1995 ($\Delta^{14}C$ = -70 - Si with radiocarbon in ‰ and silicate in µmol/kg).

Another way to visualize the ^{14}C - silicate correlation is as a section. Figure 5 shows $\Delta^{14}C$ as contour lines in silicate - latitude space for samples collected at depths between 500 and 2500 meters. In this space, shallow waters are toward the bottom of the figure. The 500 meter cutoff was selected to eliminate those samples having a very large bomb produced ^{14}C component. The 2500 meter cutoff was selected because this is the approximate depth of the $\Delta^{14}C$ minimum.

For reference the 1000 meter depth contour is also shown (heavy line). For this data set, Broecker's hypothesis works reasonably well. The $\Delta^{14}C$ isolines are reasonably horizontal and the spacing of the isolines for contours which fall below the depth of bomb-radiocarbon contamination are more or less equal. The upward curvature of the isolines with increasing latitude is consistent with the addition of "extra" silicate at depth as reported by Talley and Joyce (1992) for this region. The presence of bomb produced radiocarbon in the shallower waters is indicated by the relatively close spacing of the isolines for these waters.

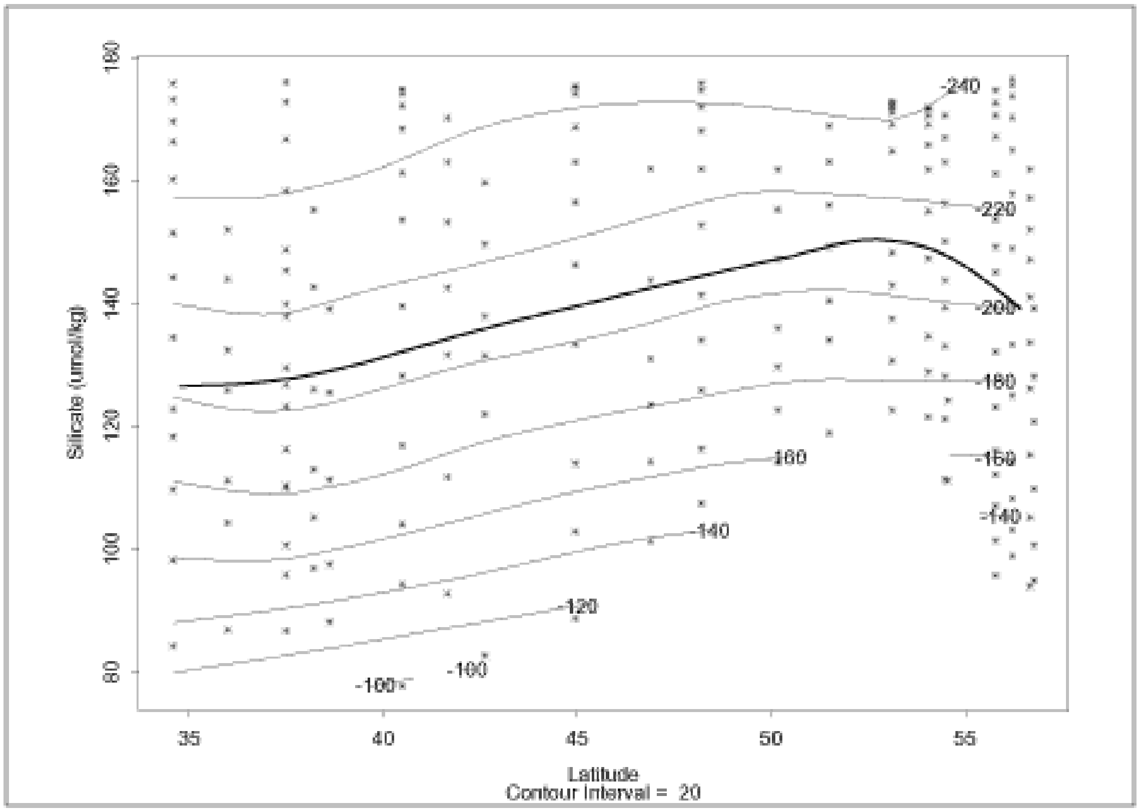

Figure 5: Section of ^{14}C contours along latitude in silicate space for the 500-2500m depth range. Note that for this section, "shallow" is toward the bottom. The 1000m depth contour is added for orientation (heavier line between -220 and -200 $\Delta^{14}C$ contours).

Figures 6-8 show $\Delta^{14}C$ contoured along the three sections of the cruise track. The "A" portion shows the upper 1.5 kilometers of the section and "B" the remainder of the water column. These figures include both AMS (Key, 1996b) and large volume (Stuiver, *et al*.1996) results. The data were gridded using the "loess" methods described in Chambers et al. (1983), Chambers and Hastie (1991), Cleveland (1979) and Cleveland and Devlin (1988). Figure 9 A-C shows the same data as Figure 6-8A except the section is plotted in potential density (σ_θ) - latitude space.

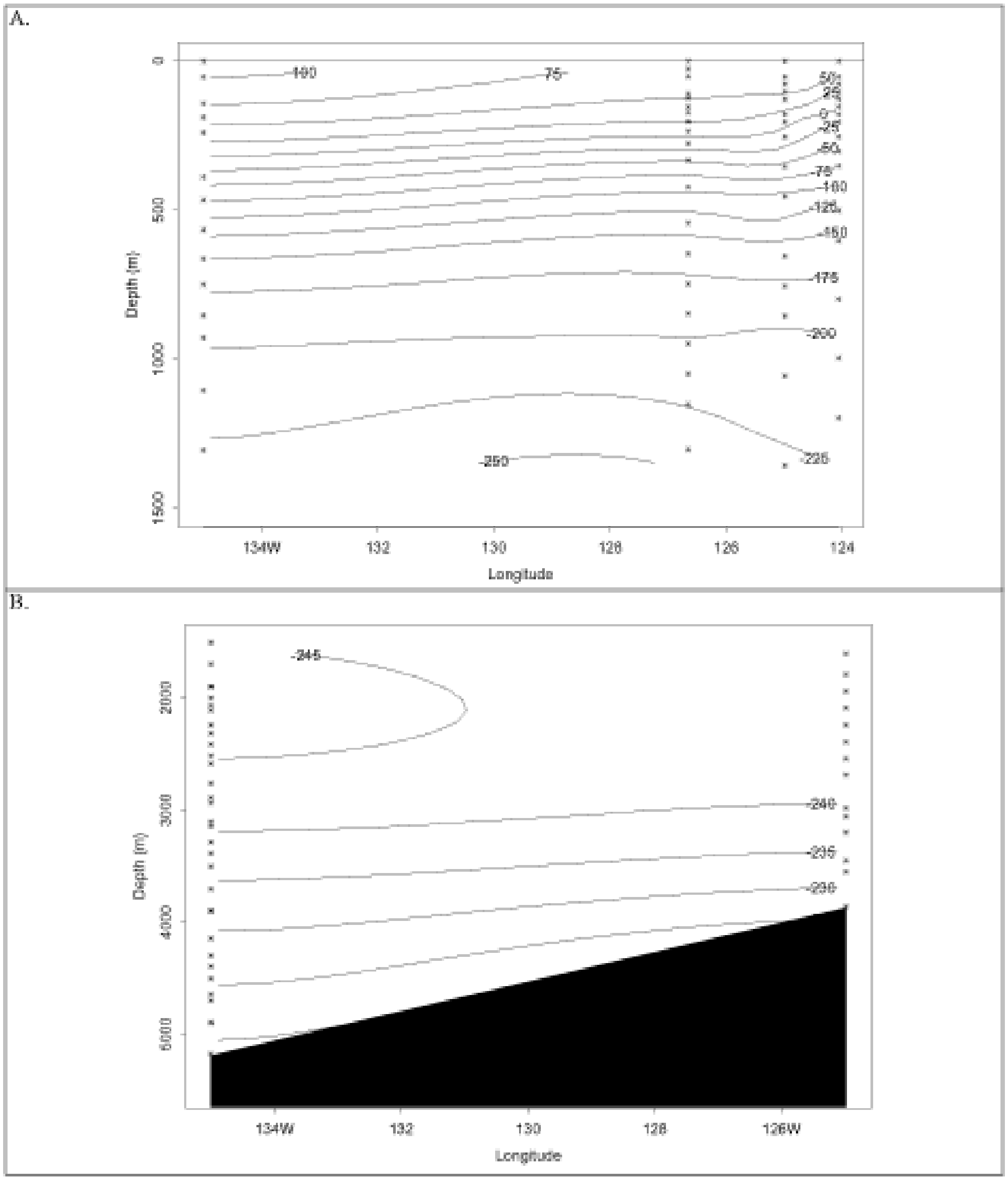

Figure 6: $\Delta^{14}C$ sections for WOCE P17N from San Francisco southwest to approximately 34°Nx135°W. The section in shown in two parts to allow more detail. In B. any existing large volume data is included to maximize the data density. See text for gridding method. The bottom topography in B is taken from cruise data, but only using those stations on which $\Delta^{14}C$ was measured.

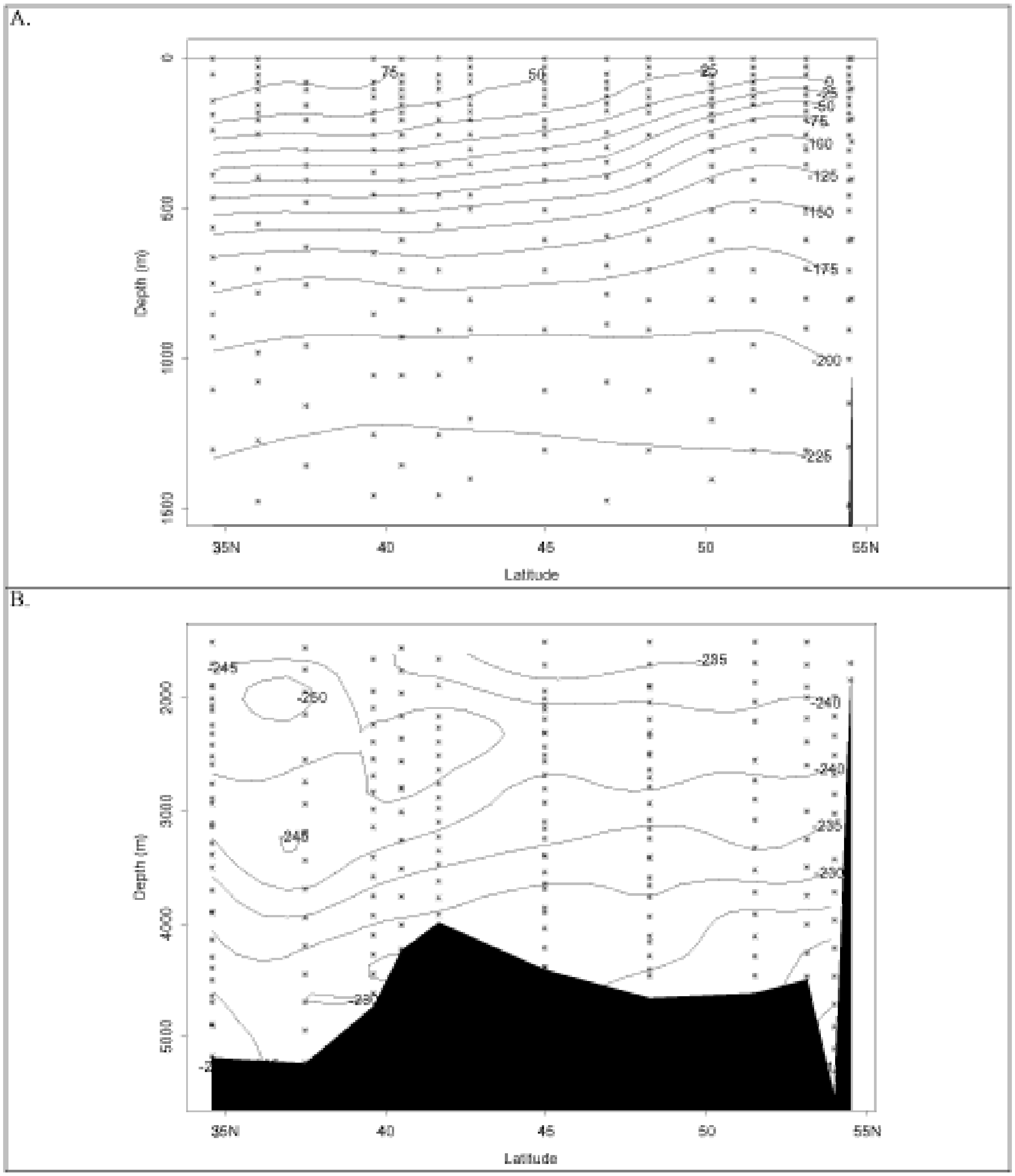

Figure 7: $\Delta^{14}C$ sections for WOCE P17N from 34°Nx135°W north to approximately 41°Nx135°W then northwestward to Dutch Harbor, AK. The section in shown in two parts to allow more detail. In B. any existing large volume data is included to maximize the data density. See text for gridding method. The bottom topography in B is taken from cruise data, but only using those stations on which $\Delta^{14}C$ was measured.

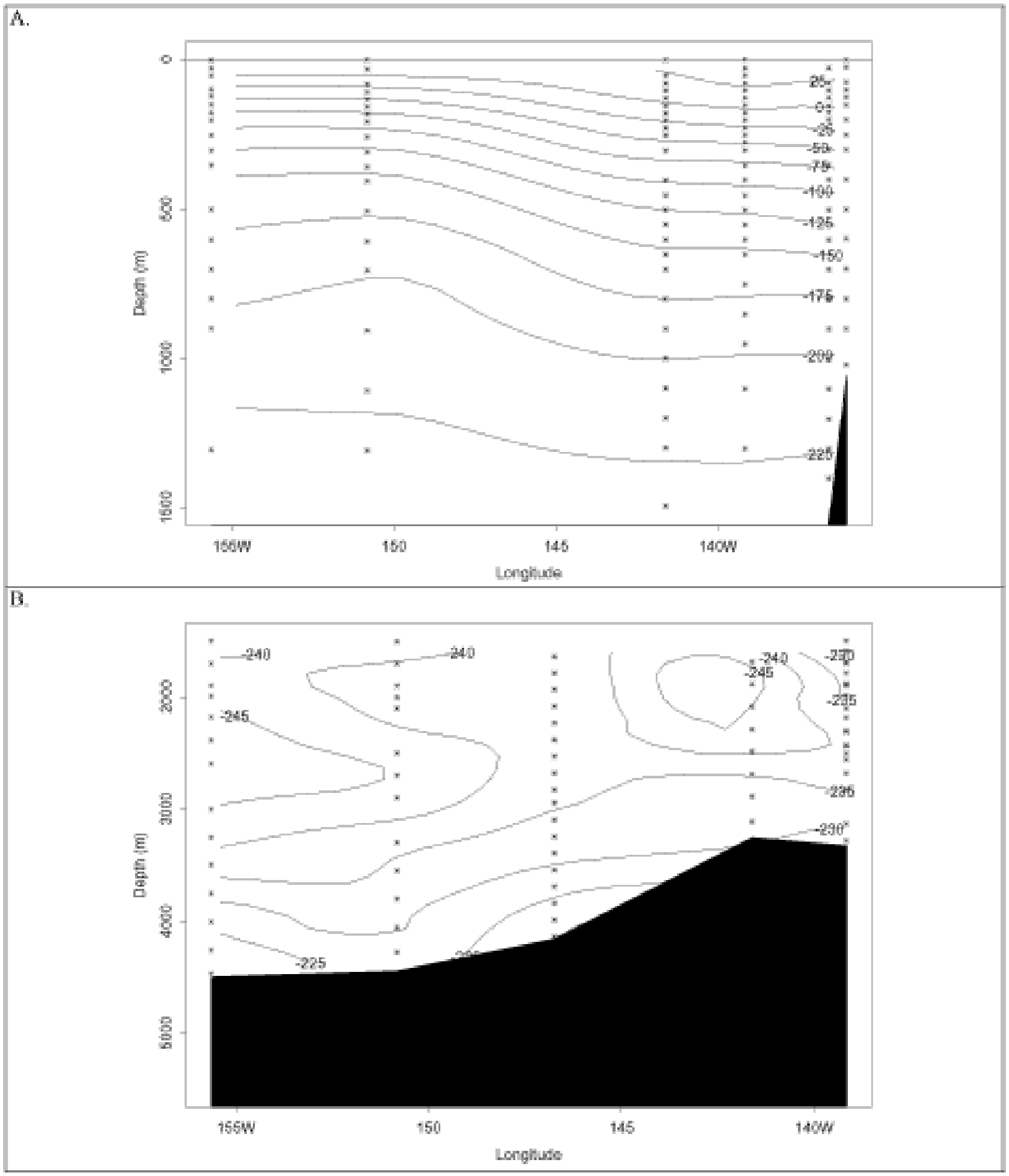

Figure 8: $\Delta^{14}C$ sections for WOCE P17N from 53°Nx156°W east northeastward to Sitka, AK. The section in shown in two parts to allow more detail. In B. any existing large volume data is included to maximize the data density. See text for gridding method. The bottom topography in B is taken from cruise data, but only using those stations on which $\Delta^{14}C$ was measured

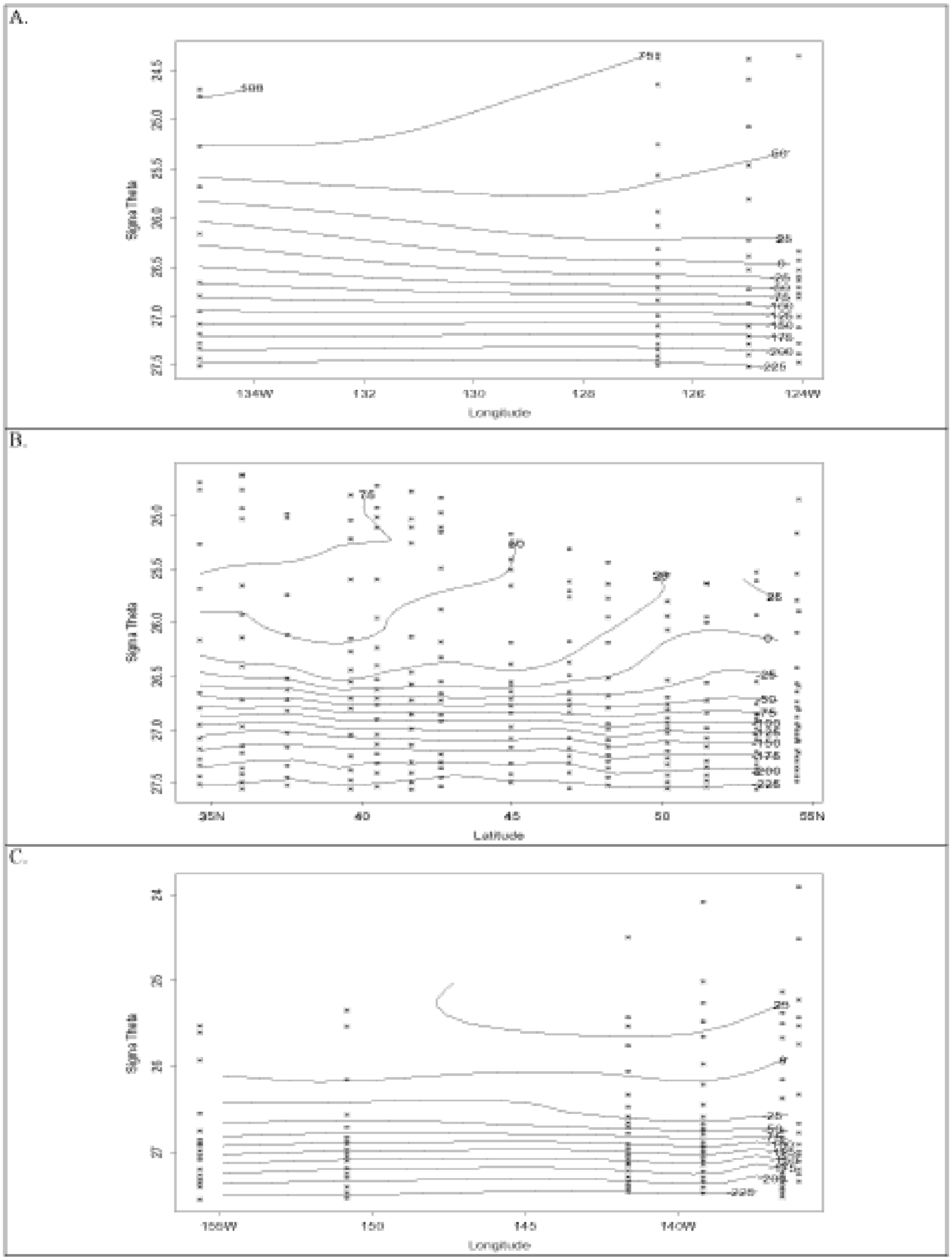

Figure 9: $\Delta^{14}C$ along WOCE section P17N plotted in potential density ($\sigma\theta$) – latitude space.

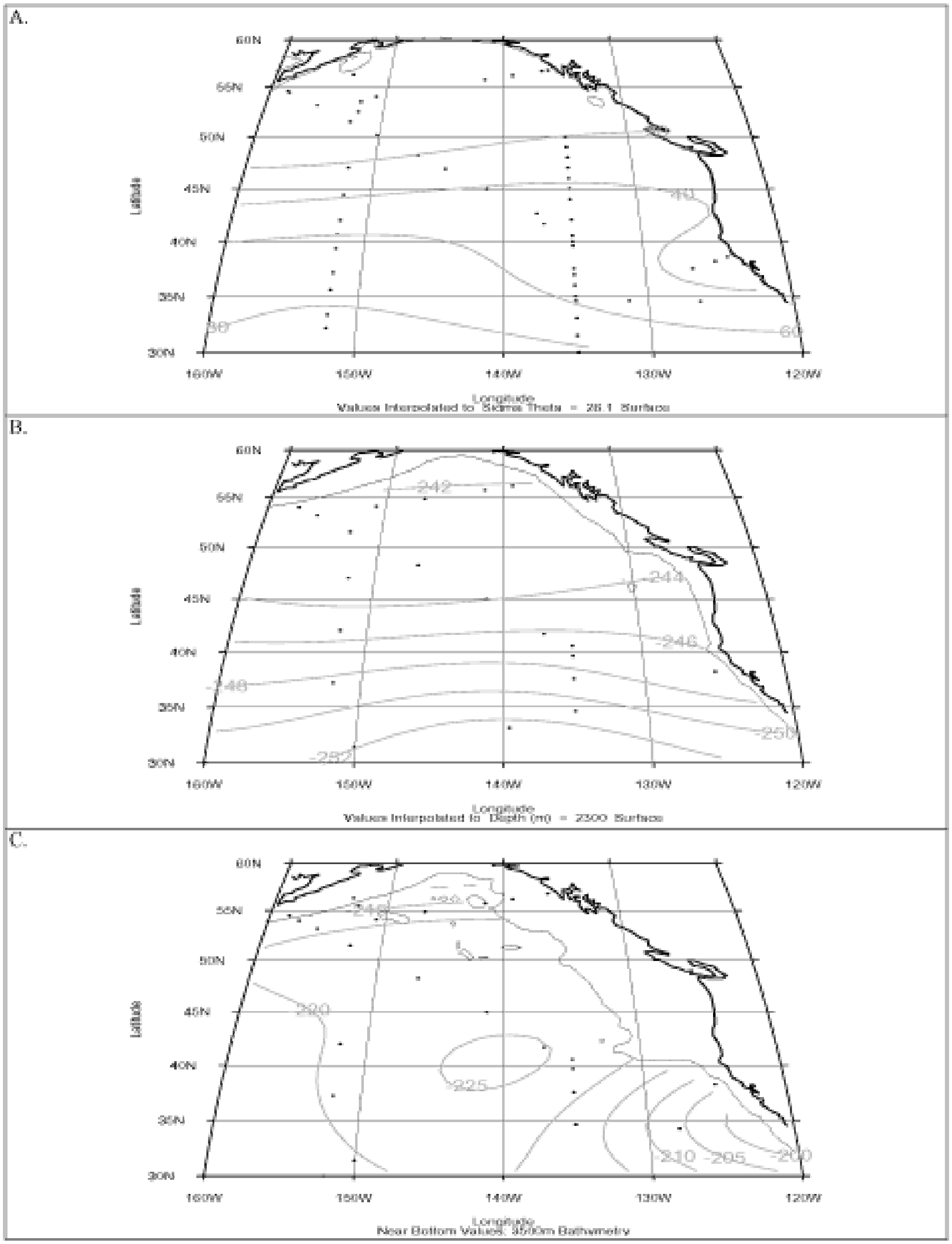

Figure 10: A. $\Delta^{14}C$ distribution on the $\sigma\theta$ =26.1. B. Distribution on the 2300m surface near the $\Delta^{14}C$ minimum. C. Near-bottom $\Delta^{14}C$ distribution for stations having bottom depth of at least 3500m.

For this region or the Pacific, the maximum $\Delta^{14}C$ concentration was always found at or very near the surface. Two features occur in each section (Fig. 6-8). First, in the upper water column the isolines show curvature near North America and second, the mid depth minimum is never occurs against the continent. These patterns are consistent with previous WOCE data sets and with the circulation described by Warren and Owens (1988). These patterns are also reflected in Figure 10 which shows 3 objective maps (Sarmiento, *et al*., 1982) of the $\Delta^{14}C$ distribution using all available data. In Figure 10A the distribution is on the σ_θ = 26.1 surface. This surface is very near the sea surface, but has no substantial outcrop in the region shown (Levitus winter data). Unlike maps for the South Pacific, the values in this region decrease poleward implying no substantial horizontal source for bomb-produced radiocarbon in the region. Figure 10B shows the distribution on the 2300m depth surface which is the approximate depth of the $\Delta^{14}C$ minimum. While the data are relatively sparse, the concentrations clearly increase southward. This result is the opposite of what is predicted by numerical model results (e.g. Toggweiler *et al*, 1989) which always predict the minimum will be against the continent along the northern boundary. The 2300m bathymetry is also shown on this map. Figure 10C shows the near bottom $\Delta^{14}C$ distribution for stations where the water depth was at least 3500m. This map shows higher values (younger) along the Alaskan coast which is consistent with inflow via the Aleutian Current from the west. The second high in the southeast portion of the map has not been investigated at this point. As in the B portion of the figure, the minimum near-bottom values are clearly in the central portion of the region, not against the continental boundary.

5.1 References and Supporting Documentation

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2000.09.20 SRA

Previous p17nhy.txt file had data and data flag problems (mainly He/Trt). Reconstrucing bottle data file.

Using hyd data from /home/whpo/sdiggs/WHPO/WHOI/DATA/P_1TIME/p17n/p17n.mka
-verified this is the same data that is in the current p17nhy.txt file

All merged files are saved in DATAMERGED dir.

1. Remerged cfc data from ...original/1999.10.20_P17N_CFC_FINE_WILLEY/FINE_WILLEY_CFS_19991020_p17n_cfcs.dat file.
   NOTE: this data is an updated cfc data set from Fine's group (per README notes in 1999.10.20_P17N_CFC_FINE_WILLEY dir). This updated data set was never merged into the previous p17nhy.txt file. In the updated data set, there are 3 samples that are not present that were present in the original data set.

sta/cst/samp	Notes:
16/1/4	niskin bottle flag = 4
19/1/5	?
67/1/6	niskin bottle flag = 4

   These problems are not further investigated.

2. Remerged tritium/helium data.
   There are 3 existing files containing tritium data. 2 of theses files came with the data set from WHOI WHPO; they are p17trt.raw and p17n.trt. The data values and data formats are different (all for the same samples) in these 2 files. It was assumed that p17n.trt contained the most up-to-date data for the period when these files were submitted to WHOI WHPO. The data flags were confusing and incorrect; they could not be correlate with the data (e.g. which flags where associated with which parameters). Correspondence with Jane Dunworth Baker at WHOI confirmed there were problems with the data flags. Data was merged into the bottle file with SIOWHPO revised data flags: missing data was flagged '9', all other values submitted were assumed to be OK and flagged '2'.
   The third existing data file contained tritium data and was from Z. TOP (1997). This is assumed to be the most up-to-date version of all tritium data for the P17N leg. The data file contained no cast values or data flags. Cast values were generated according to the sample log sheet maintained by ODF (P17N) for tritium samples taken during this expedition. Flags were generated as stated above (2 for any reported data, missing data flagged as 9).

3. Remerged LUPTON-EVANS helium data and flags. This data was already reformatted in the *LUPTON-EVANS dir.

4. Merged KOZYR tcarbn/alkali data. This data was already formatted; substituted -999.0 for -999.9 when data was missing.